学位论文

李谷好一

TRADE MARK NO. 3005

主論文

Stratigraphy of the Paleo-Biwa Group

and the Paleogeography of Lake Biwa

with special Reference to the Origin of the

Endemic species in Lake Biwa

By

Yoshikazu TAKAYA

CONTENTS

Introduction

Part I. Description part

I. Geological outline of the BIWA basin

II. Paleo-Biwa group

1. Stratigraphy

2. Key beds

3. Lithofacies

4. Fossils

5. Geological Structure

III. Terrace and Alluvial deposits

1. Terrace deposits

2. Alluvial deposits

Part II. Discussion part

Introductory note

IV. "Old Closed Lake" stage

1. Relation with the miocene Ayugawa group

2. Indicator of Continental element

3. Paleogeographical environment

4. Climatic environment

5. Debatable point

V. "Open Lake" stage

1. Indicator of marine element

2. Paleogeographical environment

VI. "Young Closed Lake" stage

1. Before deposition of the Old Terrace deposits

2. Old Terrace period

3. Young Terrace period

4. Alluvial period

Postscript

References

Stratigraphy of the Paleo-Biwa Group and the Paleogeography of Lake Biwa with special Reference to the Origin of the Endemic species in Lake Biwa

By

Yoshikazu TAKAYA

Introduction

Recently, a vast amount of data about an ancient Lake BIWA was obtained by the writer through the investigation of the Paleo-biwa group and the terrace deposits in Oomi-Iga basin, Central Japan. As the result, the geo-history of Lake BIWA has become evident almost completely. And several few interesting facts obtained by him seem to have important meanings on the problem of the relation between the basin development of Lake BIWA and the origin of endemic species. In this paper, the writer describes geological data of the post-pliocene sediments in this district and then discusses the paleogeographical problems concerning this lake, with special reference to the origin of the endemic species, in summarizing the knowledge hitherto obtained.

Among many previous works, the investigation of plant-remains by S. MIKI and the topographical survey by A. KOMATI have been most useful for the writer's work.

The writer expresses his best thanks to Dr. M. ICHIHARA for many valuable suggestions and encoragement through the present study. The writer is also indebted to Prof. S. MATSUSHITA, Prof. K. NAKAZAWA and Dr. S. ISHIDA for their kind information and discussion about the present work.

Part I

Description part

I. Geological outline of the BIWA Basin

The Oomi-Iga basin is classified geologically into the 4 groups as follows.

Alluvial deposits

Terrace deposits

Paleo-Biwa group

Basement complex

The basement complex coutains all kinds of pre-pliocene rocks such as Paleozoic rocks, Granitic rocks, Quartz porphyry and Miocene rocks, constituting the foundation of the basin and the surrounding mountains. The Paleo-Biwa group comprises loose sediments made of clays, silts, sands and gravels, which are all lacustrine in origin. These sediments now develop mainly forming hilly lands, 200-300 m. in height. The terrace deposits, consisting predominantly of gravels and sands, can be seen as a blanket on the margin of the hills. The alluvial deposits are made of clays, sands, and gravels having plant remains, all of which have been deposited in the present lake and on flood plains.

II. Paleo-Biwa group

1. Stratigraphy

Group	Formation	West of the Lake	key bed (tuff)	East of the Lake	facies
Paleo-BIWA Group	Katata Formation	B 11 50m		?	sands & gravels dominant
			Kamiōgi tuff		
		B 10 30m		B 10 40m?	
			Oono tuff		
		B 9 20m		B 9 40m	
			Ikenowaki tuff		
		B 8 ?		B 8 40m	
			Hara tuff		
		?		B 7 40m	
			Kono tuff		
				B 6 30m	
			Mushono tuff		
	Koka Formation			B 5 40m	Clay dominant
			Kosaji tuff		
				B 4 30m	
			Hozoin tuff		
				B 3 30m	
			Ichiuno tuff		
				B 2 20m	
			Yubune tuff		
	Iga For.			B 1 180m	sands dominant

The Paleo-Biwa group of about 500m in thickness shows a cycle of sedimentation of non-marine strata. The cycle begins with sands of the Iga Formation which intercalates many lignite seams. The Iga Formation is succeeded by the clayey strata of the Kōka formation and the latter passes transitionally upward to the sand and gravel rich formation of the Katata again. The relation of these three formations is stratigraphically comformable. There are many tuff beds in the Paleo-Biwa group. Some of them are so characteristic and so continuous in the area that are useful for key beds to subdivide the group. In this paper, 10 conspicious tuffs are selected and the sediments are divided into 11 beds from B_1 to B_{11} in ascending order. (In the geological map of 1/200,000 (Fig. 1) they are abbreviated into 6 parts owing to the small map's scale.) The boundaries between the formations are also drawn by tuffs respectively, even if the tuff beds cut the lithofacies diagonally.

All the sediments which are found overlying the Paleo-Biwa group are the terrace and the alluvial deposits. This fact may indicate that the younger deposits, which can be correlated to the Manchidani formation in Osaka area, do not exist in the basin.

2. Key beds

10 sheets of tuff are picked out as key bed. Almost all of them are vitric and so finely grained that the writer cannot decide their petrographic character in detail. However, they have their own feature distinguishable from each other and can be used sufficiently as key bed. The microscopic and megascopic characteristics and the physical appearence of each tuff are as follows.

<u>Yubune tuff</u> (B_1 - B_2)

This is so characteristic that has a popular local name of the "Nuka". Widely continuous and the lateral change slight owing to its intercalation in a thick clay. 50-70 cm in thickness and always consists of two parts; upper coarse-grained part and lower fine-grained part. The lower fine-grained part is yellowish gray in color and has a peculiar appearance on the weathered outcrops. That is, the many cracks develop crosswise on the weathered surface and along the cracks a lot of small (about 1 cm^3) cubic fragments are splintered off and piled up around the foot of the outcrops. The local name "Nuka" has been derived from these phenomena.

The upper coarse-grained part is gray in color and homogeneous in lithofacies. This part shows the following composition under the microscope; Clayey matrix is quite dominant, glass and quartz, 0.2-0.3 mm in diameter is scarce and few hypersthene are found. Type locality of this tuff is Higashiyubune (Loc. 85).

Ichiuno tuff (B_2 - B_3)

This is the only crystalline dacite tuff found in the Paleo-Biwa group, and one of the most useful key beds. Greenish gray to dark green, and yellowish dark gray when weathered. 15 cm. thick on an average and 20 cm. in maximum. Widely continuous and the lateral change is slight. The full succession is 3 cm. greenish gray fine-grained part, 7 cm. greenish gray medium-grained part containing dominant color minerals and 3 cm greenish fine-grained part in descending order. Under the microscope, the following materials are found in the middle coarse-grained part; Abundant quartz, rare glass, feldspar and hornblende. Type locality is the pass (1 km W of Loc. 48) between Kamimasugi and Higashiyubune.

Hozoin tuff (B_3 - B_4)

This grayish white, medium- to fine-grained tuff has not so remarkable character. But it is used as a key bed for its well continuity in the thick clay. The average thickness is 10 cm. Occasionally, this is divided into two seams by intercalation of a clay lens, a few meters thick. Abundant glass, rare quartz and very scarce hornblende are found under the microscope. Type locality is Jimpo (Loc. 74)

Kosaji tuff (B_4 - B_5)

40 cm. in average thickness. Well continuous, consisting of three layers; 10cm. yellowish gray, fine-grained top layer, 5 cm. purplish gray, fine-grained middle part and 25 cm. purplish gray, coarse-grained basal one. Especially the thick basal layer is marked with the dark brown spots, which are very useful for a key. In the coarse-grained basal part, abundant glass and rare quartz, feldspar and hornblende are found. Type locality is Nishide (1 km. NE of Loc. 74).

Mushono tuff (B_5 - B_6)

Not well continuous, but has a characteristic physical appearance and one of the most useful key beds. Consists of two parts; the upper coarse-grained, homogeneous part and the lower fine-grained, peculiarly stratified part. Though the tuff of 80-120 cm in average thickness occassionally goes laterally over into a thick drift (7 m in thickness) lens or a thinned down seam, this quite characteristic stratification can always be recognized. Under the microscope, glass is dominant and quartz, feldspar and color mineral are rarely found. Type locality is Hara (Loc. 68) and the drift is seen at Mushono (near Loc. 71).

Kono tuff (B_6 - B_7)

Not so continuous but has a rather distinct physical appearance as follows; 15 cm. brown clayey top part, 10 cm. brownish gray, finely stratified middle part and 10 cm reddish brown, coarse-grained basal part. The ratio of each part is variable but the brownish color is always useful as a common remark. The thickness which has an average value of 40 cm at Hino hill decreases rapidly westwards. So it is rather difficult to pursuet this key bed in other areas. Under the microscope, the following composition are recognized at the basal part. Fresh or half devitrified glass are common, quartz and hornblende are also found in some degree. Pyroxene is scarcely found. Typical locality is Kono (Loc. 53).

Hara tuff (B_7 - B_8)

This homogeneous white tuff is not continuous and has no peculiar physical appearence. But weathered parts show occassionally pinkish color, that is the only remark. Average thickness at Hino hill and the eastern half of the Minakuchi hill is 30-50 cm., but decreases westwards. At Kusatsu hill, the thin layer is found only in a limited area. Abundant glass, common quartz and rare feldspar and hypersthene are found. Type locality is Hara (2 km. SE of Loc. 25).

Ikenowaki tuff (B_8 - B_9)

This might be one of the two tuffs which are found on both sides of Lake Biwa; western Katata hill and eastern Kusatsu, Hino and other hills. But some doubts still remain about the identification, especially at Katata.

In spite of such a question, this tuff is regarded as a useful key bed, having somewhat remarkable physical appearance and wide distribution. It consists of the pinkish brown, clayey upper part and the pale brown, pumiceous, coarse-grained lower part with remarkable dark brown spots. The thickness varies from 20 cm. to 80 cm. Under the microscope, very abundant glass fragments, and rare quartz, feldspar and hornblende are found. Type locality is Ikenowaki (Loc. 25).

Oono tuff (B_9 - B_{10})

This is the only distinct key bed which is found on both sides of the Lake. The tuff is not so well continuous but has the very remarkable appearance quite similar to that of the so-called "Pink tuff" in the Osaka group. The "Pink tuff" is always distinguished from the rest very easily by its typical appearance, though its thickness varies from 0 to 100 cm. And the writer thinks this tuff to be the "Pink tuff" itself. Under the microscope, glass is dominant, and quartz and feldspar are rare and color minerals represented by hypersthene are very scarce. Type localities are Kitawaki (Loc. 22) on the east and at Oono (Loc. 14) on the west of the Lake.

Sakawa tuff (intercalated in B_{10})

This has been recongized only at Katata hill, and is not treated as the key bed dividing the formation in the map but useful as a supplementary key bed owing to its distinct characters as follows; Purely white, fine-grained tuff with a thin basal seam containing much biotite crystals. Average thickness is 2-4 cm. and the basal biotite bearing seam is of 0.5 cm. The continuity is comparatively good in spite of its small thickness.

Kamiôgi tuff (B_{10} - B_{11})

This is found only at Katata hill. Not well continuous and lateral charge is surprisingly great. For instance, the tuff found at Kisengawa (near Loc. 17) is 4 m. thick and represented by the alternation of the brownish gray, medium-grained part and the subordinate purplish brown, fine-grained part. On the other hand, the same tuff found at the western margin of the hill near the Hiei range is 3-7 cm. thick and brownish gray, medium-grained, homogeneous one. Thus, the lateral chang is so great that they seem as if they belong to different horizons. But they are considered to be the same one in this paper, by reason that there are many intermediate types such as 30 cm. thick, stratified tuff at Kamiogi (center of Loc. 12 & Loc. 13) and 50 cm. coarse tuff at Kurihara. (2 km. W of Loc. 17) Under the microscope, glass is abundant and quartz, feldspar, augite and hyperathene are scarce.

In any way, this tuff looks like the so-called "Azuki tuff" more or less, in its microscopic character and the stratigraphical horizon.

3. Lithofacies

B_1 bed

The sediments which filled up the uneven basement at the beginning of the series consist of various components; predominant sands and silts, with subordinate gravels, "Kibushi" clay (coaly clay), "Gairome" clay (clay with granitic granules), ordinary clay, lignites and tuffs. Till now, some efforts have been done for the classification of this thick bed, but the subdivision has been quite meaning less stratigraphically. Because the sediments have no regularity both horizontally and vertically, moreover the tuffs and another components have no remarkable characteristics. Consequently, the former subdivisions had always no meanings but showing the distribution of the sediments on the present earth's surface. In fact, the bed is made of many lenses accumulated irregularly. After all, the only one fact which has been hitherto made clear is the followings; all over the area, the under clay consisting mainly of the Gairome and the Kibushi clay with the worse sorted sands are most prominant, and the so-called basal and marginal conglomerates are not common excepting the southern foot of the Shigaraki plateau. The B_1 bed can be seen only in the Iga basin and its vicinity, but judging from the boring data obtained near Hino, it is supposed to stretch to far north area. Also another broing datum shows the thickness of the B_1 bed to be 180 m. at Ueno city. This may be nearly the maximum thickness of this bed.

B_2 bed

20-30 m. in thickness. Consisting of a widely continuous clay with a few sand lenses. Lateral change is slight. The clay abuts directly upon the granite in some places.

B_3 bed

25-35 m. in thickness. There is no characteristic difference with the B_2 in lithofacies. Consisting of a clay with a few sand lenses. Lateral change is generally slight with the exception of the local thickening of sand lens at Ômitobashi (Loc. 73). In the west, the clay abuts upon the Shigaraki granite mass., but in the east the clay laterally goes over into the sands and contacts with the basement by faults.

B_4 bed

18-30 m. in thickness. Quite similar to the B_3 in lithofacies.

B_5 bed

Clay with sand lenses, which are similar to those of the B_4. But the intercalated sands become more pronounced toward the top and are marked by the plant—bearing sandy silt at its uppermost horizon. This plant—bearing horizon laterally goes over into the Kamikomazuki coal mine (2 km. ENE of Loc. 60), where a few sheets of some 60 cm. thick lignite beds are found.

B_6 bed

10-25 m. in thickness. Upper half of the B_5 transforms upward gradually to alternation of sands and silts, which is named the B_6. Sands and silts of lenticular shape are rather well sorted and contain no coarse materials in the central part of the basin, but they change laterally into gravel rich facies near the margin. For instance, at Sasao Toge Pass (just east of the Kamikomazuki coal mine, or 2 km. NE of Loc. 60), cobbles and pebbles cemented tightly with clayey matrix abut upon the paleozoic basement.

B_7 bed

20 m+ in thickness. Lithofacies is similar to that of the B_6, but sands are larger in quantity and the lateral chang is great. Marginal part dominant in gravels is also found near Suzuka range. Coaly silts are occassionally intercalated, where the remarkable plant remains have been obtained (shown in II-4).

B_8 bed

The distribution extends on both sides of the Lake. (East of the Lake) Sands and silts are main components but coarse material are more noticeble than in the B_7 and the lateral change is also more pronounced. Alternations go over laterally into gravel - rich strata towards the eastern border, where boulders over 40 cm. in diameter are found in silt and sand lenses. Thickness increases also eastwards from less than 20 m. at Shimoda (near Loc. 61) to 40 m. at Hino hill. (West of the Lake) The identification of the Ikenowaki tuff (B_8 - B_9) at Katata hill is inaccurate, so there are some doubts about the existence of the B_8 bed at this area. But the possibility of existence is very large, judging from the thickness of the sediments and the physical appearance of the tuff as mentioned in the previous chapter.

If the lowest tuff at Katata is regarded as the Ikenowaki, the lowest portion referable to the B_8 can be said silt- and clay-rich alternation with subordinate sands. From this lithofacies, it looks like that of Taga hill.

B_9 bed

Distributed on both sides of the Lake with quite different appearance. (East) 40 m ±. Consists of gravels intercalating sands and silts. The transition from the alternation of the B_8 to the gravels of the B_9 is rapid, but no sign of disconformity is found, and the relation between the two beds is quite conformable. Gravels of 3 - 10 cm in diameter are common in the middle and lower part, but finer materials are more pronounced toward the upper. Rather fresh and round gravels are composed of mainly paleozoic rocks with subordinate granite and prophyritic materials.

(West) When above mentioned supposition about the Ikenowaki tuff is admitted, the B_9 at Katata is as follows: 5-20 m. in thickness, which is comparatively smaller than that of the east. Consists of alternation of silts and sands without any coarse materials. Gravels and pebbles are hardly found even in the nearest outcrops to the basement.

B_{10} bed

Distributed at Yokaichi hill in the east and at Katata hill in the west. (East) Consists of many lenses of silt, sands and gravels. The facies is similar to that of the upper part of the B_9. Thickness is unknown owing to the undiscovery of the Kamiōgi tuff (upper boundary of the B_{10}). But, if all the sediments lying on the B_9 are regarded as the B_{10}, they amount 40 m. in thickness.

(West) 30 m.±. Lithofacies change laterally greatly. For instance, dominant silt at Kitahama (Near Loc. 17), pebbles and gravels at Mukaizaiji (Loc. 15) and the fossil forest at Shimoryugo (center of Loc. 15 & 17). The fossil forest is represented by the carbonized woods of 50 cm thickness, which have taken their roots in the clayey matrix intercalated between the ~~bad~~ ill sorted sand and silt strata with pebbles. The horizon of the fossil forest is middle to upper of the bed. Distinct indicators of disconformity are found neither above nor beneath the fossil bed, in spite of the frequent lateral change.

B_{11} bed

Distributed only at Katata hill. Lateral change is ~~very great~~ extreme and the sediments have their own feature depending on their depositional place.

(near the ~~basement~~ backland) 40 m +. Consists of exclusively dominant gravels with slight sands and silts. Gravels are fresh, round and 3-10 cm in diameter.

(along the coast) 20 m +. Sands and silts with pebbles show occasionally the distinct cross bedding just like the delta front as shown in Fig. 3. Erosional phenomena of small scale are frequently found and many wedge shaped sands and silts with their tips landwards develop just above these erosion surfaces. The typical cross-bedding are seen at Ono (2 km SE of Loc. 16) and at Takashiro (1.5 km NW of Loc. 16).

(Intermediate part) Well—stratified and rather well-sorted sands and silt develop dominantly.

4. Fossils

Many kinds of fossil have hitherto been known in this area. Especially the plant remains which S. MIKI has reported are excellent. These fossils and their relating strata are very important for discussing the development of the basin. So the writer criticized the stratigraphical horizons of these fossil-bearing beds, checking their geological occurrences. The results are tabulated below.

5. Geological structure

The Oomi-basin is a land cauldron geostructually. It is bounded by a large number of thrusts which are divided into three characterisitc groups; the group having the trend of the Hira range (H_{1-3}), the Suzuka trend (Su_{1-6}) and those relating to the Shigaraki granite mass (Sh_{1-10}), as shown in Fig. 4. The faults belonging to the Hira trend run parallel to the Hira range indicating the distinct compression zone. Along the Suzuka range, several thrusts run side by side making échelon structure, having the NW-SE strike and NE dip, and cut the range diagonally. The faults relating to the Shigaraki granite mass develop also as thrusts with NE-SW strike. These three fault groups are undoubtedly simultaneous with the uplift of the two ranges and the projection of the Shigaraki granite body of wedge shape. Each fault has the following characteristics.

Hanaore fault (H_1)

The thrust plane dipping 60°-70° E crops out at Ichijoji and Keage. (both in Kyoto city) This strike is almost parallel to the range.

Katata region (H_2)

In this region, two faults are existing; one is the Hiei Fault which runs along the eastern foot of the Hiei - Hira range and the other is the Katata Fault which is assumed to have been buried below the alluvial deposits along the coast. And a sheared zone is hemmed in by those two faults. The Hiei Fault is composed of two or three parallel faults. Along the fault planes, sands and silts with pebbles dip almost vertically and the high angled reverse fault plane can be seen at Namazu (1 km S of Loc. 15). On the southern

Plants

Remains	Geological horizon																						
	B_1				B_2	B_4	B_5	B_6		B_7			B_8			B_9	B_{10}	B_{11}	B		
	i	ii	iii	iv				i	ii	i	ii	iii	i	ii	iii				i	ii	iii
Cephalotaxus drupacea																o					
Abies hirsuta										o											
homolepis										o											
sp.						o										o					
Picea bicolar										o											
koribai												o									
koyamai										o											
sp.						o															
Pinus Fujiii			o																	o	
koraiensis										o											
Thunbergii																o			o		
parviflora										o											
Pseudolarix kaempferi												o	o							o	
Pseudotsuga subrotunda													o								
japonica													o								
sp.												o									
Tsuga rotundata						o							o								
sieboldii										o						o					
diversifolia										o											
Cunninghamia sp.											o										o
Cryptomeria japonica																o					
Glyptostrobus pensilis	o	o	o	o			o	o			o	o	o	o						o	
Metasequoia distichcha	o		o		o		o	o	o		o	o	o	o	o				o	o	o
Sequoia sempervirens	o	o	o	o			o	o				o		o						o	o
Chamaecyparis obtusa						o				o											
pisifera												o				o					o
Thuja standishii						o				o						o					
Juglans cinerea											o		o		o						
Pterocarya multistriata													o	o							
Alnus japonica			o		o		o					o				o		o			
Fagus crenata																	o				
hayatae			o	o												o					
microcarpa																	o				
Quercus gilva																o					
crispula										o											
Zelkova ungeri																o					
Brasenia purpurea			o																		
Hamamelis parrotioides			o																		
Liquidambar formosana									o												
Sapium sebiferum									o							o	o	o			
Berchemia racemosa			o													o					
Paliurus nipponicus			o													o		o	o		
Nyssa pachycarpa	o	o																			
sylvatica	o		o					o													
rugosa	o																				
Styrax japonica					o		o		o			o									

Molluscs

Remains	Stratigraphical horizon										
	B_1	B_2	B_3	B_4	B_5	B_6	B_7	B_8	B_9	B_{10}	B_{11}
Lanceolaria oxyrhyncha				O					O		
Unio biwae	O								O		
sp.				O	O				O		
Cristaria plicata spatiosa			O						O		
sp.		O						O	O		
Anodonta sp.	O	O	O	O	O			O	O		
Corbicula sp.				O	O				O		
Viviparus longispira	O	O							O		
sp.				O					O		

Elephants

Remains	Stratigraphical horizon										
	B_1	B_2	B_3	B_4	B_5	B_6	B_7	B_8	B_9	B_{10}	B_{11}
Stegodon orientalis									?		
? sp.	O										
Elephas (Archidiskodon) paramammonteus									O		
paramammonteus ?									?		

Plants

Bed	Locality	Geological occurrence	Reporter
B_1-i	Tawara, Nabari city (3 Km NW of Loc. 99)		S. MIKI 1956
B_1-ii	Tsukigase, (5 Km W of Loc. 98)	Lignite seam	" 1948
B_1-iii	Shidatani, Shimagahara vill. (3 Km N of Loc. 97)	Coaly clay	" 1948
B_1-iv	Kamitomoo, Ayama vill. (1 Km NE of Loc. 87)	Lignite seam	" 1948, 1957
B_2	Kamiiso, Konan town (Loc. 82)	Coaly part in the silty sands	*
B_4	Iwamuro, Koka (2 Km NE of Loc. 76)		S. MIKI 1957
B_5	Stream bed of the Somakawa (2 Km NW of Loc. 71)	Lignite seam in silt	" 1948
B_6-i	East of Kaikake, Hino (2 Km SE of Loc. 54)	Lignite bed	" 1956
B_6-ii	Bessho, Hino (2 Km N of Loc. 68)	Coaly seam in the sands and silts	*
B_7-i	Kozuhata, Egenji (2 Km E of Loc. 25)	Coaly seam in the pebbles bearing silts	S. MIKI 1956
B_7-ii	"	Clayey part just beneath the B_7-3	" 1956
B_7-iii	Mikumo, Kosei (3 Km S of Loc. 63)	Lignite bed	" 1948, 1957
B_8-i	Nishidera, Ishibe (1 Km SE of Loc. 45)	Lignite bed	" 1948, 1957
B_8-ii	Shide, Taga (SE of Loc. 31)	Lignite bed	" 1948, 1952, 1957
B_8-iii	Hara, Hino (2 Km S of Loc. 25)		" 1955
B_9	Kitamuki, Katata		" 1938, 1948, 1957
B_{10}	Sagawa, Katata (1 Km NW of Loc. 14)	Coaly seam in the sands with pebbls	*
B_{11}	Mukaizaiji, Katata (Loc. 15)	"	*
B-i	Kamibeppu, Zeze, Otsu (4 Km NW of Loc. 42)	Coaly seam	S. MIKI 1957
B-ii	Nishi, Shigaraki (2 Km N of Loc. 102)	Coaly bed	" 1956, 1957
B-iii	Hosohara, Shigaraki (Just W of B-2)		" 1957

Molluscs

Bed	Locality	Geological occurrence	Reporter
B_1	Southeastern hill of Ueno city	Silt	Y. IKEBE, C. NAKAGAWA
B_2	Shindo, Ayama vill. (Near Loc. 88)	Clay	*
B_3	Koji, Konam (2 Km E of Loc. 83)	Clay	*
B_4	Jimpo, Konam (Near Loc. 74)	Clay	*
B_5	Kamikomazuki, Hino (3 Km NW of Loc. 60)	Silt	*
B_8	Kitawaki, Hino (0.5 Km E of Loc. 22)	Silt	*
B_{9-10}	Katata		N. IKEBE 1933

Elephants

Bed	Locality	Geological occurrence	Reporter
B_1	Kosugi, Ayama		SUMIDA 1958
B_9	Sakawa, Katata (1 Km SE of Loc. 14)	Silts and Sands	MAKIYAMA 1924
B_{10}-Stag.	Minamisho, Katata (1.5 Km S of Loc. 14)	Sands and silts	MATSUMOTO 1924, MAKIYAMA 1938
B_{10}-Elep.	Ogi, Katata		IKEBE 1959

* Data obtained by the writer

extension of these faults, two dykes of the same elongation intrude into the granite. The faults might occur along the frail zone suggested by these dykes. Along the eastern margin of the hill, an unsymmetrical anticline runs with a very steep eastern wing. The assumed fault line is drawn bordering this almost vertical wing. A quartz porphyry shoots out along the axis of this anticline.

The compression zone sandwiched between two faults has a peculiar appearance geostructually. That is, judging from the general distribution of the sands and silts, the strata are inclined gently towards the lake, but the bedding planes which are seen at many outcrops dip almost always toward the Hira range. These phenomena may suggest the existence of minor faults of thrust type. In fact, many minor thrusts with the shift of a few meter can be found at several places. But the detail is unknown. These conditions are shown in Fig. 5.

Two faults crossing Otsu city (H3)

Sands and silts dip almost vertically along the assumed fault line, but the type of the fault is not known.

Taga fault (Su1)

At Shide (Loc. 31), sands and silts dip steeply along the boundary with the basement. And a narrow anticline is also adjacent to this disturbed zone. This may suggest a fault of compression type. The trend of the fault coincides perfectly with that of the quartz porphyry dyke which has intruded into the paleozoic rocks.

Kozuhata fault (Su2)

At Kozuhata, paleozoic rocks are considered to thrust upon the sands and silts with pebbles, though the fault plane could not be observed. At Iwakura, on the northern extension of this fault, the strata dip at 70° to NE.

Kurotaki fault (Su_3)

The high angled thrust plane is seen at Kurotaki and Ayugawa, where the Miocene strata generally inclined eastwards suddenly change their dip steeply eastward near the fault line and the paleozoic rocks thrust over these steeply inclined sediments. The thrust extends southwards as well as northwards to the granite.

Tongu fault (Su_4)

At Kaminokumi (1 km E of Loc. 77), granite thrusts over silts and sands at a high angle. At Oono (near Loc. 60), miocene sandstone also thrusts over silts and sands at an angle of 80°. But on more northern extension, it seems to change into a normal fault. See Fig. 6.

Tsuge fault (Su_5)

Sediments dip almost vertically along the boundary between the granite and Paleo-Biwa group. But the fault plane is not known.

Yabata fault (Su_6)

Although the very point of the fault has not been known, the strata incline steeply near the boundary to the basement rocks. Moreover, in the silt beds at Kamimura (Loc. 91) and Yabata (Loc. 92), the characteristic joints of N 55°W in strike and 50° NE in dip develop regularly at interval of some 5 cm. This may be an indicator of the existence of the compressional force.

Osada fault (Sh_1)

The typical fault cliff are seen along the stream Osada and its SW extension. The figure of the cliff is quite similar to those of the Hananoki Fault and Nishitawara Fault mentioned below. But the fault plane is unknown.

Nishitawara fault (Sh_2)

At Nishitawa (4 km N of Loc. 99), granite thrusts upon the younger sediments by a fault plane dipping 55° N. And the young strata also turn over along the basement rock. See Fig. 7.

Hananoki fault (Sh$_3$)

The reverse fault is seen at Shiragashi (Loc. 97) and Hokke (3 km ENE of Loc. 97). At Shiragashi, granite thrusts upon the younger sediments with a thrust plane of 60° N in dip. Sands and silts within 10 m from the fault also dip northwards at an angle of 60°-90°.

Kawai fault (Sh$_4$)

This fault runs in the basement granite of Shigaraki plateau, but it stretches eastwards into the young sediments at Ayama hill. At Umada (1 km W of Loc. 87), a reverse type fault is found, where granite basement protrudes in the area of sands and silts along the fault line and the strata incline steeply.

Shimagahara fault (Sh$_5$)

At Okude (3 km W of Loc. 96), granite thrusts upon the younger deposits at high angle, and gravel-rich strata along the fault dip almost vertically. This fault is traceable also at Suwa (6 km NE of Loc. 96), where coaly clay inclines steeply.

Koyama fault (Sh$_6$)

This fault runs in granite basement. And the younger sediments do not incline steeply. Fault type in unknown.

Nagano fault (Sh$_7$)

At Nishi (2 km N of Loc. 102), the young sediments dip vertically along the boundary to the granite. This may indicate the existence of fault, but the type is unknown.

Ofuku fault (Sh$_8$)

Gravels dip steeply along the fault line. But the fault plane is unknown.

Mikumo fault (Sh$_9$)

At Mikumo (on the left bank of Yasu River), the granite mass thrusts over the younger deposits at high angle (almost vertically). But this thrust transforms to a normal fault on its east extension. General dip of the strata near Yama (4 km ENE of Mikumo) is 40°N. See Fig. 8.

Konan shear zone (Sh$_{10}$)

This shear zone is represented by 3 fault lines in the geological map. (A zone sandwiched in between western 2 fault lines) In this region, a lot of minor thrust run parallel to the basement range, having some 5 m thift. But the strata are suffered from little disturbance, or the ruptures occurs almost always in the flat strata without any strong inclination. Only along the two lines drawn in the geological map, the steeply dipping strata are recognized accompanied by a thrust type fault.

(along eastern one) Strata dip vertically along the assumed fault line, but the type and the fault plane cannot be ascertained. This fault transforms to an anticline on its northern extension and near Minakuchi (1 km E of Loc. 71) granite basement juts out into the younger deposits along the axis of the anticline.

Shiomoda anticline (S$_1$)

The anticline has a steep south wing and a gentle north one. Some attendant minor faults run along the north wing, where strata dip vertically occasionally.

Kaikake fault (S$_2$)

Along the boundary between the Paleo-Biwa group and the basement, the sands and silts incline at a dip of 60°-80° N. suggesting the existence of a fault. But this fault transforms to a fold on its western extension. At Minakuchi hill, the strata form a steplike shape, having the rather steep north wing (10-30°) and the gentle tilted (1-5°) south wing.

III. Terrace and Alluvial deposits

1. Terrace deposits

The terracedeposits in Ômi basin can be classified into the Old Terrace (Nunobikiyama Formation) and the Young Terrace (Yokaichi Formation). And the Old Terrace is divided further into the Upper Old Terrace and the Lower Old Terrace.

The Upper Old terrace developes on the top of hills along the lake or streams, having the height from 125 m near the ~~coast~~ Lake to 340 m in the inland. This means that the blanket of the Upper Old terrace overlies the hills locally but its depositional surface does not rise above the summit plane composed of the Paleo-Biwa group. The sediments consisting of predominant gravels are strongly affected by the red-soil-formation and dissection of the depositional surface is fairly advanced.

The Lower Old terrace is situated lower than the Upper terrace topographically. Along the Coast it lies over the gently-lowered hills, and along the stream it develops stepwise on the circumference of the hills as a small scale river terrace. The shift from the Upper Old Terrace is gradual without any terrace-cliff and red-soil-formation are considerably advanced. As a whole, the Lower Old terrace is very similar to the Upper one and it seems natural to thick that both are summarized to one series. The Lower Old terrace is bounded by the Young terrace or the Alluvial plane with a tiny terrace-cliff frequently. But whether it extends beneath the alluvial deposits or not is unknown through the field observation.

The typical Young Terrace can be seen only along the upper course of the large rivers. The highest depositional surface comeup over 15 m. higher than the present stream bed, but it lowers downstream and disappears below the Alluvial plane around the mid-stream. The deposits consisting predominantly of gravels are quite fresh and the dissection can hardly be recognized. The relation of these three terraces are shown in Figs. 9,10,11 & 18.

Seta — Otsu region

On the hilly land between Seta and Kusatsu, the typical Old terraces develop facing to the Lake, as shown in Fig. 1 and Fig. 9. The Upper Old terrace over lies the hills having the depositional surface of 125 - 155 m in height, which is about 25 m lower than that of summit plane of this hilly land. The Lower Old terrace has a wide depositional surface from 95 m to 125 m in contour. It develops on the top of the lowered hills or as the inclined small-scale patches on the circumference of the hills, of which tops are covered with the Upper Old Terrace. Between the Upper and the Lower terraces, a narrow area having a little steeper slope are seen at the height from 120 to 130 m, but any terrace-cliffs cannot be found. Both terraces are quite similar to each other in their lithofacies. They consist predominantly of gravels of 2-6 cm in diameter and clayey matrices become more pronounced tward the top. The average thickness is 5 m and strong red-soil-formation are recognized.

In general the Lower Old terrace is bounded by the Alluvial plane with the slight terrace cliff, 1-2 m in high. However, the strongly weathered Old terrace along the Seta street is situated at 87 m in contour exceptionally, which is at least 3 m below the present Alluvial plane. This fact indicates the Lower Old terrace exists beneath the Alluvial deposits at least in this locality. As mentioned above, the broad existence of this formation below the alluvial plane is still in question, but it exists certainly in the special places. At Otsu, the Old Upper terrace attains the height of 170 m or more. But this is not the real terrace but of fan or talus. The Young terrace can not be found in this region.

Katata region

On Katata hill, the deposits correlative to the Old Terrace develop mainly as a fan along the foot of Hiei and Hira ranges. The distributions are from 340 m to 22o m in height at Kurihara (west of Loc. 17) 280-180 m at Namazu (west of Loc. 15), 240-190 m at Kamiogi (west of Loc. 12), and their inclination atains 5°-15°. The average thickness is 2-5 m., but locally gets over 10 m. Their components are predominantly granite boulders and gravels, strongly affected by the red-soil-formation. Subdivision into the Upper and the Lower is difficult, except a distinct Lower Old terrace at Kamiryuge (2 km west of Loc. 16) along River Wani.

The Young terraces are also of fan type. One is at the foot of Mt. Ryozen, which is composed of cobbles and boulders. The other is at the foot of Mt. Hiei, where fresh arkose sands containing granitic gravels develop under 120 m in height. The deposits are quite similar to that of the Kita-shirakawa fan which is developing on the just opposite side of Mt. Hiei. These deposits seem to disappear below the Alluvial plain.

Along the River Echi

On the left side of River Echi, the Upper Old terrace consists of gravels and sands with silts which are strongly affected by the red-soil-formation. Their depositional surface is distributed on the top of the hills, inclining slightly toward the river. Its height varies from 260 m in the eastern highest part to 170 m in the western transitional part to the Lower Old terrace. This means that the surface is situated 100 m and 30 m higher than the present stream bed of the Echi respectively and is a little lower than that of summit plane composed of the Paleo-Biwa group. The thickness is less than 10 m and dissection is well advanced.

The Lower Old terrace consisting of gravels, sands and silts which are also suffered the strong red-soil-formation covers the hills continuously from the above stated Upper terrace in the eastern part, but it is lowered gradually westward and finally disappears below the Young terrace deposits. On the other hand, the overlying gravels on the right side which is correlated to the Old terrace deposits have the considerably fan-like appearance adjacent to the steep Suzuka range. These gravels distribute from the height of 280 m to 160 m and seem to belong to the Old Lower terrace.

The Young terrace consisting of the fresh gravels and sands develops on both sides of the River Echi, with a fan-like distribution. The depositional surface of this sediment decreases westwards. Consequently, the scarp facing to the river also decrease its height westwards, for example, 13 m at Ogura, 6 m at Sone (2 km below Ogura) respectively in height and disappears at Kishimoto (5 km below Ogura). The boring data also show that the basal erosion surface of the Young terrace exist 15 m below the Alluvial plane at Gokanosho (Loc. 2, 11 km below Ogura). This may well suggests that the depositional surface of the Young terrace is existing some ~~10~~ 5 m below the Alluvial plane and may more lower on the far western extent. The thickness of these deposits is 2-6 m. These relations are shown in Fig. 10.

Along the River Hino

The Upper Old terrace can not be found in this area. The Lower Old terrace consisting of gravels, sands and silts develops around the Hino hill with the maximum height of 200 m, which is about 35 m above the present Hino stream. The degree of the red-soil-formation is just like as that of Echi's Lower Old terrace. The average thickness is 5 m.

The Young terrace is also quite similar to the Echi's in its physical appearance. The depositional surface is 12 m above the present stream at Nihongi (1 km N. of Loc. 54) and disappears below the Alluvial plain at Uchinoike (3 km S of Loc. 51 and 5 km below Nihongi). The fan-like appearance is pronounced at the upper part of the stream.

The Young terrace transforms to the typical fan at Zao (2 km above Nihongi). The thickness at the terrace part is 2-4 m.

Along the River Yasu

The Upper Old terrace develops on the tops of the two small hills which run parallel with the River Yasu on its both sides. The depositional surface varies from 300 m in height (80 m above the present river bed) at Oono (1 km E of Loc. 60) to 235 m (50 m above) at Shinjo (1 km S of Loc. 69). The deposits are consisting of predominant gravels with clayey topset and strongly suffered the red-soil-formation. The thickness is 5 - 10 m.

The Old Lower terrace can be found only on the right side of the river near Oono. It develops as step-like patches of small scale on the mid-slope of the hills from just beneath the Upper Old terrace to just above the Young terrace. The red-soil-formation is considerably strong. The Young terrace, 2-5 m thick, distributes along the River Yasu and its tributary Soma. Along the main stream, the depositional surface attains to 8 m above the present stream bed at Ichiba (1.5 km S of Loc. 60) and 4 m at Shinjo (5 km below Ichiba). On the other hand; along tributaries, it locates 8 m above the stream bed at Hirata (1 km N of Loc. 83) and 4 m at Ichihara (2 km W of Loc. 72, and 6 km below Hirata). The Young terrace is not visible along the downstream from the confluence of these two rivers.

Iga basin

The Post Paleo-Biwa sediments may not be exactly correlated to that of Oomi basin, but have similar characters in appearance and distribution. Fig. 11 shows the NE-SW cross section at Yabata (Loc. 92) and it can be referred as the standard profile of the overlying blankets in Iga basin.

The typical High gravel bed can be found on the southern hills of Tsuge, where the gravels distributed flatly on the top of the hills increase its height eastwards and transform to a fan at the foot of the Suzuka range. The components are granite boulders and cobbles with clayey matrix and strongly affected by the red-soil-formation. The thickness is 4-8 m, and the surface is strongly dissected.

The widest and the most typical Middle gravels are found at Ueno city, where the considerably weathered gravels attain a thickness of 3-6 m and have a well-preserved depositional plane. At the hilly region, south of Touge, the coordinate gravels develop on the hill sides or filling the small valleys between the hills. These gravels are affected by red-soil formation and dissected by the streams which have the still younger gravels along them. The depositional surface of the Lower gravels is situated at a few meters above the Alluvial plane.

For instance, at Nishinosawa (2 km E of Loc. 93) it is 6 m above the present stream bed and also 6 m at Tomioka (4 km SSW of Loc. 92). The sediments, 3-4 m thick, are always fresh. Along the southern foot of the Shigaraki plateau, the above mentioned three gravels are recongized, but the exact classification is difficult owing to their steep inclination and small distribution.

2. Alluvial deposits

Fig. 12 is drawn from 100 boring columns along the New Tokaido trunk line. This is the best part which have hitherto been made clear about the alluvial deposits. In this profile, only one point has to be noticed. That is, the boundary between the cobbles and sands may not mean the unconformity plane of the alluvial deposits, but coincides with that of the Young terrace. This interpretation seems to be natural, judging from the status of the terrace on the ground. However, the data about the alluvial deposits are very poor, in considering the great lateral change of the lithofacies. And the writer can say very little about the youngest deposits.

Part II

Discussion part

Introductory Note

<u>Essential point</u>

Lake Biwa has a great number of endemic species in its fauna and flora which differ remarkably from those of the other parts of Japan. Kuroda (1948) reported many characteristic molluscs such as Heterogen longispira, Semisulcospira decipiens, S. niponica, Radix onychia, Gyraulus biwaensis, G. amplificatus, Lanceollaria oxyrhyncha, L. biwae, Inversidens reiniana, I. hirasei var. I. brandti, Hyriopsis shlegeli, Anodonta lauta tumens, A. calipyros, Corbicula sandai, Pisidium kawamurai, Sphaerium japonicum biwaense. And he indicated that they are similar to the continental ones. Kitamura (19—) stated that the characteristic plants such as Vitex rotundifolia, Cabystegia soldanella, Lathyrus maritimus, Arabislyrata sub sp. Kawasakiana, and Pinus Thunbergii might have originated in sea side area. On the other hand, Ueno (1937) who studied the fishes of Lake Biwa insisted that the fauna of Lake Biwa is conspicions in mixing of both the northern and southern species. However, the analyses on these endemic species are not formulated at present. Limnologists and biologists have said that some of them might have resulted from immigration and others may be of autochthonous intra-lacustrine evolution. The writer agrees with this interpretation in principle. Probablly, such phenomena might have resulted from the long history of this lake since its birth as well as in its large lake space and considerable depth.

In the writer's opinion, the existence of such miscellaneous species might be the result of immigration in many times when the topographical barrier permitted to their migration. In other words, he thinks that the paleogeography may at least have a kind of hint to dissolve the problem of these endemic species. The outline of his interpretation is compiled in Table 13 and Fig. 14. Namely, Lake Biwa has three characteristic stages, which provide quite different conditions for the invasion of the biota to Lake BIWA.

(1) "Old closed Lake" stage: The ~~period~~ age of invasion of the continental elements, Late pliocene.

(2) "Open Lake" stage: The ~~period~~ age of invasion of the marine elements, Earliest pleistocene.

(3) "Young closed Lake" stage: The ~~period~~ age of land — locking, Early pleistocene ⟶ present.

<u>Premise</u>

Prior to discussions, the writer has to settle some fundamental supposition on which basis he will argue in detail.

1) Indicator of the environment

(Continental element) — The word "Continental" is not used in the strict sense, but used as "non-marine" with dominant ~~continental~~ chinese characters. It is said that Hyriopsis schlegeli and Semisulcospira libertina resemble very much the present continental molluscs in the coast region. Lanceolaria, Anodonta, Viriparus and other ~~species~~ molluscs found in Lake Biwa are also considered as marker of the fresh-water. So the writer has picked up these fresh water molluscs as the indicator of the so-called "Continental" element.

(Marine element)— The writer has no adequate data about fossil diatoms, and fossil fishes could not be found. The only species which indicates the marine environment in this case is a plant remain, Pinus Thunbergii. Prof. Kitamura says that the present distribution of Pinus Thunbergii is limitted to the coastal region, excepting a cliff of Mt. Myogi (near Tokyo). Judging from such status, it is natural to think that Pinus Thunbergii is a relic of "marine" origin, or it might have invaded this basin when the Lake had a close connection with the sea. Thus, though the marine elements ~~are~~ exist, they are practically very slight in its evidence. The writer's so-called "Marine" element is of just like a slight one.

2) Indicator of the age

ITCHIHARA (1961) discussed "The problem of stratigraphical horizon of extinction of Metasequoia flora", and established the Quaternary chronology in central Japan as follows: Pliocene is represented by the Metasequoia flora with dominant Tertiary type flora such as Pseudolarix, Liquidambar, Ginkgo, Pinus fujiii and Keteleeria. Earliest pleistocene is remarked by the Metasequoia flora without the Tertiary type flora. And then the non-Metasequoia flora period succeeded during the whole pleistocene. So the writer has adopted this chronology established by M. ITIHARA and has arranged plant-remains as an indicator of the age.

IV. "Old Closed Lake" stage

"Closed" has not a limnologically strict sense. It means that the Lake keeps its isolated environment from the sea and topographically marine dwellers to be unable to invade the Lake, no matter whether there are any waterway reaching the sea or not.

1. Relation with the Miocene Ayugawa group

The miocene Ayugawa group did not suffer strong crustal movement during pre-Paleo-Biwa age. The sediments of the Paleo-Biwa group overlie these miocene sediments almost parallel geostructurally. But the faunal assemblages are quite different from each other; the former has 66 species of typical marine molluscs (IKEBE 1934), on the contrary, the latter has no marine species. All the marine molluscs might perfectly extinct between the Ayugawa and the Paleo-Biwa.

2. Indicator of Continental element

Unio biwae, Anodonta sp. and Viviparus longispira are found at the lowest part of the sediments (the B_1) belonging to the this formation. Other species such as Lannceolaria oxyrhyncha, Cristaria plicata spatiosa and Corbicula sp. are also seen at this stage.

3. Paleogeographical environment

Chain-like distribution of lakes

Y. FUJITA (1962) showed a paleogeographical map of the late pliocene age, as quoted in Fig. 15, when he discussed a historical review of Japan Sea. In this map, Japan islands are shown as a part of the continent with a few fresh water lakes distributed parallel to the coast.

Water-ways between the lakes

Emeritus professor J. MAKIYAMA informed the writer the small distribution of the gravels and silts along the stream Uda. This fact may well suggest the existence of a water-way along this route in the B_1 ~~age~~ time. At the same ~~age~~ time, other suspicious water way is supposed along the present stream Kasagi by a few patches of gravels. On the other hand, the dacite tuff found at Tamate-yama hill, southeast of Osaka, may possibly be correlated to the Ichiuno tuff (B_2 - B_3) of Paleo-Biwa basin. Judging from these facts and stratigraphical condition in Osaka and Nara basins, the writer thinks that a few water-ways have stretched to the Awaji island across the Kitan straits, at the beginning of the Paleo-Biwa series.

Simultaneously or just after the birth of these opening water-ways, the third drainage is suggested to have passed also from Iga-Oomi basin to the Awaji island via Shigaraki and Nara. As to the relation with the Age basin, there is found a zonal area that looks suspicious to have allowed the presence of anold channel, intersecting the Suzuka range, but the writer can not find any deposits along this zone. Consequently, the existence of a water-way between these two basin is doubtful.

Even topography

The sediments of this stage are composed of predominant fine materials such as sand, silt and clay excepting northeastern marginal part of the Iga basin. In this basin, the B_1 bed so frequently has under-clay in stead of basal conglomerate. And clays belonging to the B_2 - B_5 beds also often about the basement. This fact indicates the topography surrounding the lake was considerably even, so that it did not produce the dominant coarse meterials.

4. Climatic environment

From the B_1 to B_5, we can find the tertiary type flora such as Pinus fujii, Pseudolarix, Liquidambar and Nyssa, in addition to the Metasequoia flora, which indicate the warm climate like tertiary. But suddenly, a thin seam intercalated in the upper part (?) of the B_7 produces the cold indicators such as Pinus koraiensis and Tsuga sieboldii, which are the first striking imformers of cold climate during the Paleo-Biwa period. Then the Metasequoia flora without the tertiary type flora took the place of Pinus koraiensis, indicating again the mild climate. Chronologically this first cold horizon represented by Pinus koraiensis coincides with the end of the "Old Closed Lake" stage. Consequently, the writer can say that the climate has been warm throughout the "Old Closed Lake" age.

5. Debatable point

S. MIKI (1948) has got Paliurus nipponicus from the coaly clay at Shimagahara, Mie Prefecture, which belongs to the B_1 bed. As to the allied present species, Paliurus ramosissimus is popular in the coastal region of China, Loochoo and West Japan. And P. australis is familiar in arid area from southwest Asia to Mediterranean district through southern central Europe. In general, P. nipponicus is considered to be common in marine clays of the upper part of the Osaka group, if anything. However, it should be debatable whether this Paliurus has had any connection with the sea. The writer wants to think that P. nipponicus is unrelated to the sea, but he has no adequate data at present concerning this question.

V. "Open Lake" stage

The "Open Lake" means that the Lake had a broad channel connecting to the sea without any distinct topographical barriers, though it was thoroughly lacustrine.

1. Indicator of marine element

As above-mentioned, Pinus thunbergii which has been found at the B_9 bed is the only indicator of the marine element.

2. Paleogeographical environment

Basin-making movement of basement

The writer classified the Paleo-Biwa group into three formations, considering their lithofacies, which are summarized as follows: The lowest Iga formation is composed of ill sorted sands and silts and generally lacks the marginal gravels.

The middle Koka formation is of clayey sediments without marginal conglomerates. Contrary to them, the upper Katata formation consists of sands, silts, gravels and generally with predominant marginal gravels. The marginal gravels appear for the first time at the B_6 bed. This phenomenon suggests that the condition around the Lake was not the same before and after the B_6. That is, the gravels of the Katata formation may be the result of the basin-making movement and of the consequent higher land surrounding the Lake. The evidence that the upper beds are distributed more northwards also agrees with this movement.

Birth of the Gonokuchi Channel

In accordance with the basin-making movement, the center of the depositional area might shift northwards. Consequently, at the B_8 time, sands, silts and gravels have become to expand their distribution far northern and more broad area. The writer thinks that the sediments on the mountain region east of the River Uji also contain the B_8 bed at their basal part. And moreover, he suppose that this deposits can be traced to the gravel-rich strata at Aotani region, which are correlated to the lower part of the Osaka group. These suppositions, as a natural consequence, results the idea that a new channel was born at the B_8 ~~age,~~ time which has named the "Gonokuchi Channel".

The sediments along the channel part are composed mainly of gravels, but at their basal part thick clayey layers are often found, which have ever been mined for raw material of roof tiles. And the distribution attains to 3-6 km in width.

Considering these appearences, the writer interprets that the "Gonokuchi channel" was 3-6 km in width and especially at the early stage it was so stagnant that clay could deposit in this part.

Approach of the Sea water

Before considering the condition of the then Osaka ~~tuff,~~ bay, the writer wants to try more exact stratigraphical correlation between the Paleo-Biwa and the Osaka group. Fig. 16 shows the stratigraphical relation of 4 places being connected by the channel. The only but the definite key bed common to the both basins is the "Pink tuff". As to this tuff, though the writer has not found it hitherto, he thinks that it must be intercalated in sands and gravels in the channel part. Moreover he supposes that the Channel might exist at least near the "Yamada tuff" horizon. This judgement is based on the following affirmative evidences; first, the gravels above the "Yellow tuff" attain to more than 80 m in thickness, which indicates enough thickness for the apperence the "Yamada tuff", and second, the lithofacies at Katata hill changes greatly at the "Yamada tuff" horizon ("Sakawa tuff" horizon as will be stated below in detail). With these proofs, the writer decides the horizon of the top of the sediments in the Channel part, as shown in Fig. 16. On the other hand, the "Yellow tuff" and the "Ikenowaki tuff" found at the basal part of the sediment in this region indicate that the beggining of the Channel coincides with the "Yellow tuff" horizon.

Now let the writer show the paleogeographical environment of Osaka — Kyoto area during the "Open Lake" stage. The outline is shown in Fig. 17. At the early stage of the Channel, (perhaps the B_8 and the early B_9) the Osaka — Kyoto area was covered by the lacustrine waters. The first transgression occured at the late B_9 ~~age~~ time, or just before the "Pink tuff". At that time, the sea invaded to Takatsuki and probably to Mukomachi, though Fukakusa region was left as a lacustrine. In Nara and Aotani, the marine clay (ITUJIHARA has called this clay Ma_1) has not hitherto been found. Probablly these regions might be a part of a fresh water regions. This sea regressed at the end of the B_9, then whole Osaka — Kyoto area changed again to be lacustrine till the next transgression at the middle of the B_{10} in age. The second invasion of the sea brought marine clays (Ma_2) to the Mukomachi and Uji. The writer thinks that the marine elements might invade in the vicinity closer to the Channel than at the first time, although the evidence of the transgression was not found at Nara and Aotani regions as before. After the second marine invasion, several transgressions with marine clays (Ma_3 - Ma_8) were repeated in Osaka — Kyoto area, but the Channel seems to have been already going to close its route as retreating of the second sea. Afer all, the marine water might have approached to the entrance of the channel at least towice during the "Gonokuchi Channel" stage, but it could not invade the Channel.

Disappearance of the Gonokuchi Channel

The Channel disappeared around "Azuki tuff" horizon, partially due to the basin-making movement as well as due to another origin. The writer has sufficient evidences for this phenomenon of lowering water level and disappearance of channel will be stated below as follows. The most direct proof of disappearance is the lacking of the sediment along the Channel of that stage. The second is the more indirect proof, that is, at Katata hill, the character of the sediments changes greatly at the boundary of the "Sakawa tuff" (correlative of "Yamada tuff"), where the such as distinct crosslamination are recognized and this tendency become more pronounced toward the upper. The writer thinks that the scour-and-fill structure (confer Fig. 3) is the result of lowering of the waterlevel. Devleopment of the fossil forests of the B_{11} ~~age~~ time may also be an accompanying phenomenon.

VI. "Young Closed Lake" stage

The emergence of the Paleo-Biwa Lake has advanced hand in hand with the development of the basin making movement. And at the climax of this movement, the Paleo-Biwa group might be displaced or steeply inclined by the faults. After the climax, the youngest blankets of gravels overlied horizontally the the folded and faulted Paleo-biwa group. This is the most simplified history of the Lake sine the end of the "Open Lake" stage.

As afore-mentioned, the basin has suffered so strong crustal movement, consequently the topography in the vicinity of the Lake might have varied greatly during this revolutional ~~period~~ age. But in the writer's opinion, whatever might happen, the Lake has never taken the occasion any more to have such a great channel as "the Gonokuchi" since its disappearence at the B_{11} age. And he named this last stage without broad channel the "Young Closed Lake" ~~stage~~ time. Perhaps, almost all the species which had invaded before and during the "Gonokuchi Channel" stage were compelled to become the perfect land-locked ones. And in regard to the topography, this new term was a preparatory stage for constructing the present Oomi basin and Lake Biwa.

In this chapter, the writer wants mainly to discuss the history of the paleogeographical development of the basin.

Subaquatic topography

Before entering the discussion, the writer wants to show the Kotani's work about subaquatic topography and outline of its tentative correlation to the terestrial one. Kotani (1957, 1958, 1960) has stated that the present Lake Biwa has 4 distinct subaquatic terraces; the subaquatic terrace ("Kodan") III,II,I and the lake bottom plain. These 4 planes have the following depth, for example, off the River Hino: The subaquatic terrace III: 3-5 m, the II: 8-14 m, the I: 17-23 m and usually the bottom plain is at 76-79 m below the present lake level. Adding to these 4 planes, he has reported another smaller scaled P_I plane between the I and the bottom plain, which has ordinarly rather steep inclination. The writer interpretes these 4 subaquatic planes may be correlated to the terrestrial ones respectively. Fig. 18 shows the tentative correlation between them, on which he will discuss in more detail.

1. Before deposition of the Old Terrace deposits

As above-mentioned, there is a long interval in time between two sediments, the Paleo-Biwa group and the Old Terrace deposits. This fact may well suggest that the Paleo-Biwa group has experienced a complicated geohistory before the latter's deposition. The most interesting point is the problem whether the Lake has once perfectly disappeared or not. But unfortunately, the writer has no adequate data at present concerning this question.

Origin of the Lake Bottom Plain

Instead of discussing the direct problem "whether the Lake has disappeared or not", the writer will consider on the origin of the "Bottom plain", though it is also quite uncertain.

If the writer arranges the subaquatic and terrestrial planes following the order of their each situation, the "Bottom plain" should be correlated to the "Paleo-Biwa plane" formally, as shown in Fig. 18. But this formal correlation might be meaningless, because the character of the plain is still vague, consequently the real meaning of this plain is unknown. However according to the writer's supposition, the following two cases seem to be possible to explain its origin: The first case is that the plane was formed by the erosional action of the then lake water. If this assumption is acceptable, we have to conclude that the lake has maintained its level as low as that of the present bottom plain for a considerably long time. The second is the case in which some faults play an important role. For example, along the west side of the Lake, we find a remarkable Katata fault, by which the eastern block is depressed scores of meters as against the west block which now constitutes the Katata hill. This phenomenon may suggest the possibility of the origin of the Bottom plain. At present it cannot be assumed whether any faults exist along the east side of the lake or not, being buried below the alluvial deposits. In other words, it is within the range of possibility that the Bottom plain might be originated by such faulting action not only along its western side but all around the Lake. Supposing that the former erosional force is true, it may be possible that the lake has lowered its level 75 m ± below the present at its lowest age. However at present, it is debatable which one was real and whether a quite different another factor was a prime agent. The only definite fact is that many kind of endemic species have been survived throughout this period.

2. Old Terrace period

Tentative correlation between the terrestrial and subaquatic planeS

The subaquatic terrace I has a broad flat plane at 20-25 m below the present lake level, for example off Hino. But its physical character is unknown. Consequently, the correlation tried by the writer at present is quite tentative and not conclusive. The only fact which gives evidence in favour of this tentative correlation is the entonnire of which Kotani (1958) has reported. He has stated that the entonnire at 3.6 km off the Amanogawa delta (north of Hikone) situates 27 m below the present water level, digging the stratified sediments which constitute the terrace I, with a scale of 100 m in diameter and 5 m in depth. And he has suggested that the entonnire was formed by driving action of the ground water's gush. The writer thinks that the main way of shallow ground water might be limited to the gravel dominant strata of the terrace, accordingly the existence of the entonnire may well suggest that the plane on which the entonnire situates means an existence of gravel rich fan-like deposits. On the other hand, the fact that the subaquatic Terrace II is correlated to the Young Terrace is fairly well certain. Judging from there two conditions, the writer wants to think that the Terrace I can be correlated to the Old Terrace.

Paleogeography

First of all, the writer has to state that the general topography has become considerably similar to that of the present one, for the first time at this stage. A frame work of the present water system has achieved at this Old terrace age, and no great trans-formation has occured since this time. For example, a new water way, the River Uji has been born instead of the Gonokuchi channel anc a few large rivers such as the Echi, the Hino, the Yasu and the Ado have taken their places along their present route. The Old shore-line at this time is also traceable. The terrace gravels on the Seta hill indicate that the Lake level was 60 m higher than the present one at its climax (confer Fig.9). But this higher water level lowered then gradually. And supposing that the correlation shown in Fig. 18 is correct, we have to think that the lake level has dropped about 20 m below the present at its lowest pitch of the depression. This phenomenon also means an interesting fact that the River Uji dried up perfectly and the lake had no draining water-way, during this lower leveled period. By the way, the drainage dries up at a gorge of Sekinotsu, Otsu city, when the lake level lowers 3 m below the present one.

Age

The sediments found on land are affected strongly by the red-soil formation. Its degree is quite similar to that of the "Meimi gravels" (High Terrace gravels in Osaka — Akashi area, cf. ITIHARA 1961), and the dissection advanced also considerably. From these conditions, the writer thinks that the Old Terrace is nearly same as the High Terrace of Osaka — Akashi area in age.

3. "Young Terrace" period

Correlation between the terrace and the subaquatic plane

The writer should think that the correlation between the Young Terrace and the Subaquatic Terrace II is of moral certainty. He can cite the following three facts as its proof. i) The depositional surface of the Young Terrace which is more than 10 m high above the present stream bed at the upper-course of rivers lowers its height downstream and then disappears below the alluvial plane without any terrace cliff. ii) Judging from the boring data, (confer Fig. 12), the basal plane of the cobble has a depth of at least 15 m below the alluvial plane at Gokanosho (Loc. 2 in Fig. 1). This fact suggests that the cobble base means the erosional basal plane of the Young Terrace deposits rather than the alluvial one. Because the thickness of 15 m, is too large for that of the alluvial deposits at this place. iii) Among three sediments (The Old Terrace, the Young Terrace and the Alluvial deposits), the Young terrace gravels have a particularly large grain size. Similarly the Subaquatic Terrace II is composed of large grain-sized materials such as gravèls with coarse sands, which are coarser than those of the I and III. (Kotani 1957) These three facts seem to justify the above mentioned correlation.

Paleotopography

The inclination of the depositional surface of the Young Terrace is quite uniform, contrary to the step-like appearance of the Old Terrace. And the deposits are almost always unseen in the lower part of rivers or coastal region, sinking below the alluvial plain. These two facts indicate that the Lake has been constantly low or gradually lowering its level during this period. The writer wants to think the former case was probable, because of nearly perfect lacking of terrestrial deposits referred to the Young Terrace along the coastal region. Once such interpretation is accepted, the following topography may be deduced from it. That is, the then lake level was approximately 10 m lower than the present, consequently the River Uji dried up. And the gradient of the flow-in-rivers was 0.05° steeper than the present ones.

Age

A considerable amount of submerged archeologic remains from early "Jomon" to latter "Yayoi" in age are found on the subaquatic terrace III,II and occaionally on the bottom plain. These might be useful indicators if we check their geological occurrence. Unfortunately the writer has had no chance to observe them immediately and has no adaquate data concerning this problem. The only fact that he can state with confidence is limited to the feature of the Terrace itself as follows; the gravels are fresh, being not suffered by the red-soil formation and dissction is hardly recognized. Accordingly, he supposes that the Young Terrace is simultaneous or younger than the Itami gravels (Low Terrace is Osaka — Akashi area, ISHIHARA 1961) and may be alluvial in age by some possibility.

4. "Alluvial" ~~period~~ age

The shallowest plane is called the "shelf" (hikudana), the delta (Sankakusu) or the Subaquetic Terrace III (Dai III kodan) by Kotani (1956) and he has subdivided it into more detail. In any way, the writer thinks that this plane can be traced to the alluvial plain as a whole. Kotani has also stated that the recent lake reached maximum expansion at the middle of Nara period and then retreated its coast line at the present position. This tendency has continued till the present day.

Postscript

The writer has established three stages of Paleo-Biwa Lake in the sense of Paleogeography and correlated each of them to the characteristic three age ~~periods~~ preparing the chance of immigration for the biota, which are now called relics or endemic species. Hereupon, the writer has to make an additional remark about the accuracy of his investigation and then indicate a few future problems.

His investigation has been done as much as possible from the view point of geology, but it is still incomplete on the biogeographical and limnological aspect. The reason is that his work has been done mainly on the basis of the geological field observation about the terrestrial proof. After due consideration of such condition, he can point out the following themes as the future problems.

i) Problem of the subaquatic terraces.

The writer supposes a perfectly isolated lake without any drainage, in some period of the "Young Closed Lake" stage. This might be a quite interesting problem not only for the geologists but for the limnologists, in the connection of its physico-chemical character of the then lake. The writer is expecting various critisism about this point from many scientists. The most important work might be centred round the subaquatic terraces, in geologically and geodosically speaking.

ii) More exact observation of fossils

To discuss the relation of the geohistory and biogeography, more exact observation of the fossils are required. Especially, the writer thinks, the investigation of the diatom fossils is the most useful for this problem.

iii) Correlation with the Akashi and Age groups

The Ichiuno tuff (B_2-B_3) and the horizon of extinction of the tertiary type flora are considered to be useful keys for correlating the plio-pleistocene strata in Kinki district. The writer thinks that the latter represented by the cold indicators is the best for establishing the standerd chronology in this district, in company with the horizon of extinction of the Metasequoia flora.

References

Araki, Y. (1960): Geology, Paleontology and Sedimentary structures of the Tertiary Formations Developed in the Environs of Tsu City, Mie Pref. Japan. Bull. Lib. Arts. Dep. Mie Univ., Vol. 1, pp.1-118.

Fujita, Y. (1962): Origin of the Japan Sea. (in Japanese) Earth Science (Chikyu Kagaku) No.62, pp. 21-26.

Fukakusa Research Group (1962): Plio-Pleistocene deposits at Fukakusa, southeast Kyoto. (in Japanese) Earth Science (Chikyu Kagaku) No. 63, pp.1-9.

Hirose, M. (1934): Geology of the southeastern part of the Lake Biwa (in Japenese) Globe (Chikyu) Vol. 21, pp. 91-105.

Horie, S. (1961): Paleolimnological Problem of Lake Biwa-Ko. Mem. Col. Sci. Univ. Kyoto, series B, Vol. 28, pp.

Huzita, K., Ikebe, N., Ichihara, M., Kobatake, N., Morishima, M., Morishita, A., Nakagawa, C. and Nakaseko, K. (1951): The Osaka group and the related Cenozoic formations. (in Japanese) Earth Science (Chikyu Kagaku) No. 6, pp. 49-60.

Huzita, K. (1954): Stratigraphic significance of the plant remains contained in the Late Cenozoic formation in central Kinki, Japan. Jour. Polyt. Osaka City Univ., Ser. G, Vol.2, pp. 75-96.

————, Kokawa, S., Kasama, T. and Ichihara, M. (1959): Geology and structure of Nishinomiya Area.(in Japanese) History of Nishinomiya City, 1, pp. 174-316.

————. (1962): Tectonic Development of the Median Zone (Setouti) of Southwest Japan, since the Miocene, with special reference to the Characteristic structure of Central Kinki Area. Jour. Geosci. Osaka City Univ., Vol. 6, pp. 103-144.

Ichihara, M., Huzita, K., Morisita, A. and Nakaseko, K. (1955): Stratigraphy of the Osaka Group in the Senriyama Hills. (in Japanese) Jour. Geol. Soc. Japan, Vol. 61, pp. 433-441.

——————.and Oguro, J. (1958): On the Akasi Group and the Harima Group. (in Japanese) Earth Science (Chikyu Kagaku) No. 40, pp. 13-20.

——————, Oguro, J. and Kinugasa, H. (1960): On the Akasi Group and Harima Group (II). (in Japanese) Jour. Geol. Soc. Japan, Vol. 66, pp. 605-615.

——————. (1960): Some Problems of the Quaternary sedimentaries, Osaka and Akasi Area. Earth Science (Chikyu Kagaku), No. 49, pp.13-25.

——————. (1961): Some Problems of the Quaternary sedimentaries in the Osaka and Akasi Area, Japan. Jour. Polyt. Osaka City Univ., Series G, Vol. 4, pp. 13-30.

Ikebe, N. (1933): Paleo-Biwa Series, a pleistocene deposits in the area west of Lake Biwa. (in Japanese) Globe (Chikyu), Vol. 20, pp. 241-260.

——————. (1934): Miocene strata of the eastern part of Koga-gun, Oomi. (in Japanese) Globe (Chikyu), Vol. 22, pp. 110-123.

——————. (1959): Stratigraphical and Geographical Distribution of Fossil Elephants in Kinki District, Central Japan. (in Japanese) The Quarternary Research, Vol. 1, No.4, pp. 109-118.

Kokawa, S. (1954): Geology of Mt. Mikasa and its environs, Nara prefecture, with special reference to the geologic age of "Mikasa-andesite". (in Japanese) Jour. Geol. Soc. Japan, Vol. 60, pp. 487-495.

——————. (1954): Volcanostratigraphic Aspect of Mt. Mikasa and its Environs, Nara Pref., Japan, with special Reference to the Geologic Age of "Mikasa-andesite". (in Japanese) K.K. Yotokusha, Tenri city. Nara.

Kotani, A. (1957): Subaquatic Topography of Lake Biwa. (in Japanese)
G S I Jour., No.21, pp. 12-16.

————. (1958): Lake Bottom Topography and Fishing. (in Japanese)
G.S I Jour. No. 22, pp. 16-21.

————. (1960): Geoscientific Consideration of Submerged Archeologic Remains at Katsuraozaki, northern part of Lake Biwa. (in Japanese)
G S I Jour., No. 24, pp. 8-11.

Kuroda, T. (1947): Freshwater molluscs of Lake Biwa. (in Japanese)
Yumehamaguri, No. 19: pp.2-7, No.20: pp.2-15, No.21: pp.2-9.

Miki, S. (1933): On the Pleistocene Flora in Prov. Yamashiro with the Descriptions of 3 New Species and 1 New Variety. Bot. Mag. Jap., Vol. 47, pp. 619-631.

————. (1938): On the change of Flora of Japan since the Upper Pliocene and the Floral Composition at the Present. Jap. Jour. Bot., Vol. 9, pp. 213-251.

————. (1941): On the Change of flora in Eastern Asia since Tertiary Period (I), The clay or lignite beds flora in Japan with special reference to the Pinus trifolia beds in Central Hondo.
Jap. Jour. Bot., Vol. 11, pp. 237-303.

————. (1948): Floral Remains of Kinki and Adjacent District since the Pliocene, with Description of 8 new Species. (in Japanese)
Mineralogy and Geology (Kobutu to Tisitu), No. 9, pp. 105-144.

————. (1950): A Study on the Floral Remains in Japan since the Pliocene.
Sci. Rep. Osaka Liberal Arts Univ., No. 1, pp. 69-116.

————. (1950): Taxodiaceae of Japan, with Special Reference to Its Remains. Jour. Polyt. Osaka City Univ., Vol. 1, pp. 63-77.

————. (1952): Trapa of Japan with Special Reference to Its Remains.
Jour. Polyt. Osaka City Univ., Vol. 3, pp. 1-30.

Miki, S. (1955): Nut Remains of Juglandaceae in Japan. Jour. Polyt. Osaka City Univ., Vol. 6, pp. 131-144.

———. (1956): Seed Remains of Vitaceae in Japan. Jour. Polyt. Osaka City Univ., Vol. 7, pp. 247-271.

———. (1956): Remains of Pinus koraiensis S. et Z. and Associated Remains in Japan. Bot. Mag. Jap., Vol. 69, pp.448-454.

———. (1956): Endocarp Remains of Alangiaceae, Cornaceae and Nyssaceae in Japan. Jour. Polyt. Osaka City Univ. Vol. 7, pp. 257-295.

———. (1957): Pinaceae of Japan, with Special Reference to Its Remains. Jour. Polyt. Osaka City Univ., Vol. 8, pp. 221-272.

———. (1958): Gymnospermus in Japan, with Special Reference to the Remains. Jour. Polyt. Osaka City Univ., Vol. 9, pp.125-150.

Oye, Y. (1958): The second study on the prehistoric site in Lake Biwa, Kohoku-cho, Higashiazaigun, Shiga Pref.. (in Japanese) Bull. Kyoto Gakugei Univ., Vol. 8, pp. 42-66.

Sakamoto, T. (1954): Cenozoic Formation in the Southern District of Nara City. (in Japanese) Jour. Geol. Soc. Jap., Vol. 61, pp. 62-72.

Suzuki, K. (1949): Development of the Fossil Non-Marine Molluscan Fauna in Eastern Asia. Jap. Jour. Geol. Geogr., Vol. 21, pp. 91-133.

Takaya, Y. and Ichihara, M. (1961): The Quaternary Deposits of the Hirakata Hill, with Special Reference to Climatic Changes recognized in the ShinKori and the Hirakata Member. Jour. Geol. Soc. Jap., Vol. 67, pp. 584-592.

Takehara, H. (1961): Stratigraphy of the Age Group, Northern Mie Pref. Japan. Professer Jiro MAKIYAMA Memorial Volume (in Japanese)

Ueno, M. (1943): The inland water fauna and flora in the regions of the Western Pacific. Marine and Inland Waters of the Pacific, (in Japanese) pp. 817-884.

Aburahi	滋賀縣甲賀町油日
Adogawa	〃 安曇川町
Âge	
Akashi	兵庫縣明石市
Amemaru	滋賀縣栗東町雨丸
Aotani	京都府久世郡青谷
Asada	滋賀縣石部町麻田
Awaji	兵庫縣淡路(島)
Ayama	三重縣阿山郡
Ayugawa	滋賀縣土山町鮎河
Bata	三重縣阿山郡馬田
Bessho	滋賀縣日野町別所
Bodaiji	〃 甲西町菩提寺
Echi	〃 愛知(郡)
Êgenji	〃 永源寺町
Fukakusha	京都市深草
Fukawa	滋賀縣甲南町深川
Gamodo	〃 蒲生町蒲生堂
Gokanoshô	〃 五ヶ荘町
Gokenchô	〃 大津市五軒町
Gonokuchi	京都府宇治田原町郷之口
Hananoki	三重縣上野市花木
Hara	滋賀縣日野町原
Hasama	〃 日野町迫
Hiei	比叡(山)
Higashide	滋賀縣信楽町東出
Higashiyubune	三重縣阿山村東湯舟
Hino	滋賀縣日野(町)
Hira	比良(山)
Hirata	滋賀縣甲賀町平田
Hokke	三重縣上野市法花
Hosohara	滋賀縣信楽町柞原
Hozôin	〃 甲南町法蔵院
Ichiba	〃 土山町市場
Ichihara	〃 甲南町市原
Ichijoji	京都市左京区一乗寺
Ichiuno	滋賀縣甲賀町櫟野
Ikenowaki	〃 永源寺町池之脇
Ishibe	〃 石部(町)
Ishido	〃 蒲生町石塔
Itami	大阪府伊丹(市)
Iwakura	滋賀縣秦荘町岩倉
Iwamuro	〃 甲賀町岩室
Iwane	〃 甲西町岩根
Jimpo	〃 甲南町神保
Kaikake	〃 日野町鎌掛
Kami Higashi	〃 甲賀町神東
Kami Kita	〃 甲賀町神北
Kamibeppu	〃 大津市膳所上別府
Kamiiso	〃 甲南町上磯尾
Kamikomazuki	〃 日野町上駒月
Kamimasugi	〃 甲南町上馬杉
Kamimura	三重縣伊賀町上村
Kaminokumi	滋賀縣甲賀町上ノ組

Kamiogi	滋賀縣堅田町上仰木	Kusatsu	滋賀縣草津(市)
Kamiryuge	〃 堅田町上龍華	Kyoto	京都(市)
Kamitomoo	三重縣上野市上友生	Mikumo	滋賀縣甲西町三雲
Kamitsuge	〃 伊賀町上柘植	Minakuchi	〃 水口町
Kasagi	京都府相楽郡笠置	Minamisho	〃 堅田町南庄
Kasuga	滋賀縣水口町春日	Mukaizaiji	〃 堅田町向在地
Katata	滋賀縣堅田(町)	Mukomachi	京都府向日町
Kawai	三重縣阿山郡河合	Mushono	滋賀縣水口町虫生野
Keage	京都市蹴上	Myogi	妙義(山)
Kisengawa	滋賀縣滋賀郡喜撰川	Nabari	三重縣名張(市)
Kishimoto	〃 愛東町岸本	Nagano	滋賀縣信楽町長野
Kitanama	〃 志賀町北浜	Nakatomoda	三重縣阿山郡中友田
Kitamuki	〃 堅田町北向	Nakaya	〃 阿山郡中矢
Kitan	紀淡(海峡)	Nakayama	滋賀縣日野町中山
Kitashirakawa	京都市北白川	Namazu	〃 堅田町生津
Kitawaki	滋賀縣日野町北脇	Nara	奈良(市)
Kôji	〃 甲南町柑子	Nihongi	滋賀縣日野町二本木
Kôka	〃 甲賀(町)	Nishi	〃 信楽町西
Kônan	〃 甲南(町)	Nishide	三重縣上野市西出
Kono	〃 日野町小野	Nishidera	滋賀縣石部町西寺
Kosaji	〃 甲賀町小佐治	Nishinosawa	三重縣阿山郡西之沢
Kosei	〃 甲西(町)	Nishitawara	〃 名張市西田原
Kosugi	三重縣阿山郡小杉	Nunobikiyama	滋賀縣甲賀郡布引山
Koyama	滋賀縣信楽町小山	Odawara	〃 大津市大石町小田原
Kozuhata	〃 永源寺町甲津畑	Ofuku	京都府宇治田原町大福
Kuramochi	三重縣名張市蔵持	Ogawa	滋賀縣信楽町小川
Kurihara	滋賀縣志賀町栗原	Ogi	〃 雄琴町仰木
Kurotaki	〃 土山町黒滝	Ogoto	滋賀縣大津市雄琴(町)

Ogura	滋賀県愛東町小倉	Shinjo	滋賀県水口町新城
Okuda	京都府南山城村奥田	Shiragashi	三重県上野市白樫
Omitobashi	滋賀県甲南町大水戸橋	Soma	滋賀県日野町杣
Oomi	近江(国)	Somakawa	〃 水口町杣川
Oono	滋賀県堅田町大野	Sone	〃 愛東町曽根
Oono	〃 土山町大野	Suwa	三重県阿山郡諏訪
Osada	三重県名賀郡長田(村)	Taga	滋賀県多賀(町)
Osaka	大阪(市)	Takagi	〃 永源寺町高木
Osanoyama	京都府宇治田原町長山	Takamine	〃 甲賀町高嶺
Otsu	滋賀県大津(市)	Takano	〃 甲賀町高野
Ryozen	滋賀県滋賀郡霊仙(山)	Takashiro	〃 志賀町高城
Ryuboshi	〃 甲南町竜法師	Takatsuki	大阪府高槻(市)
Sakawa	〃 堅田町佐川	Tamataki	三重県阿山郡玉瀧
Sanagu	三重県上野市佐那具	Tamateyama	大阪府柏原市玉手山(丘陵)
Sasao Tôge	滋賀県日野町笹尾峠	Tawara	三重県名張市田原
Sekinotsu	〃 大津市田上関津町	Tomioka	〃 大山田村富岡
Sencho	〃 大津市石山千町	Tongu	滋賀県土山町頓宮
Seta	〃 瀬田(町)	Toriidaira	〃 日野町鳥居平
Shibahara	〃 瀬田町芝原	Tsuge	三重県柘植町
Shidatani	三重県島ヶ原村半出谷	Tsukigase	奈良県添上郡月ヶ瀬
Shide	滋賀県多賀町四手	Uchinoike	滋賀県日野町内池
Shigaraki	〃 信楽(町)	Uda	奈良県宇陀(郡)
Shijuku	三重県上野市四十九	Ueno	三重県上野(市)
Shimagahara	三重県阿山郡島ヶ原(村)	Uji	京都府宇治(市)
Shimoda	滋賀県甲西町下田	Wani	滋賀県志賀町和邇
Shimoryuge	〃 堅田町下竜華	Yabata	三重県伊賀町山畑
Shindo	三重県伊賀町新堂	Yama	滋賀県水口町山

Yamamotoshinden	滋賀県日野町山本新田
Yamashiroonsen	京都府城陽町山代温泉
Yasu	滋賀県野洲(郡)
Yokaichi	〃　八日市(市)
Yono	三重県上野市予野
Yubune	〃　阿山村湯船
Zao	滋賀県日野町蔵王
Zeze	〃　大津市膳所

Fig. 5 B-11 bed showing the scour and fill structure.

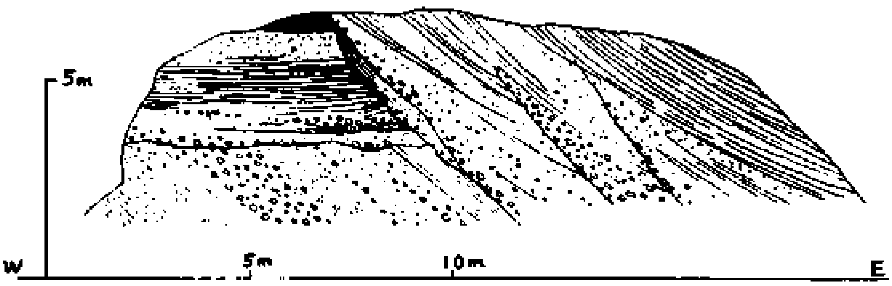


Fig. 4 Structural map of the Oomi-Iga basin and its surroundings.

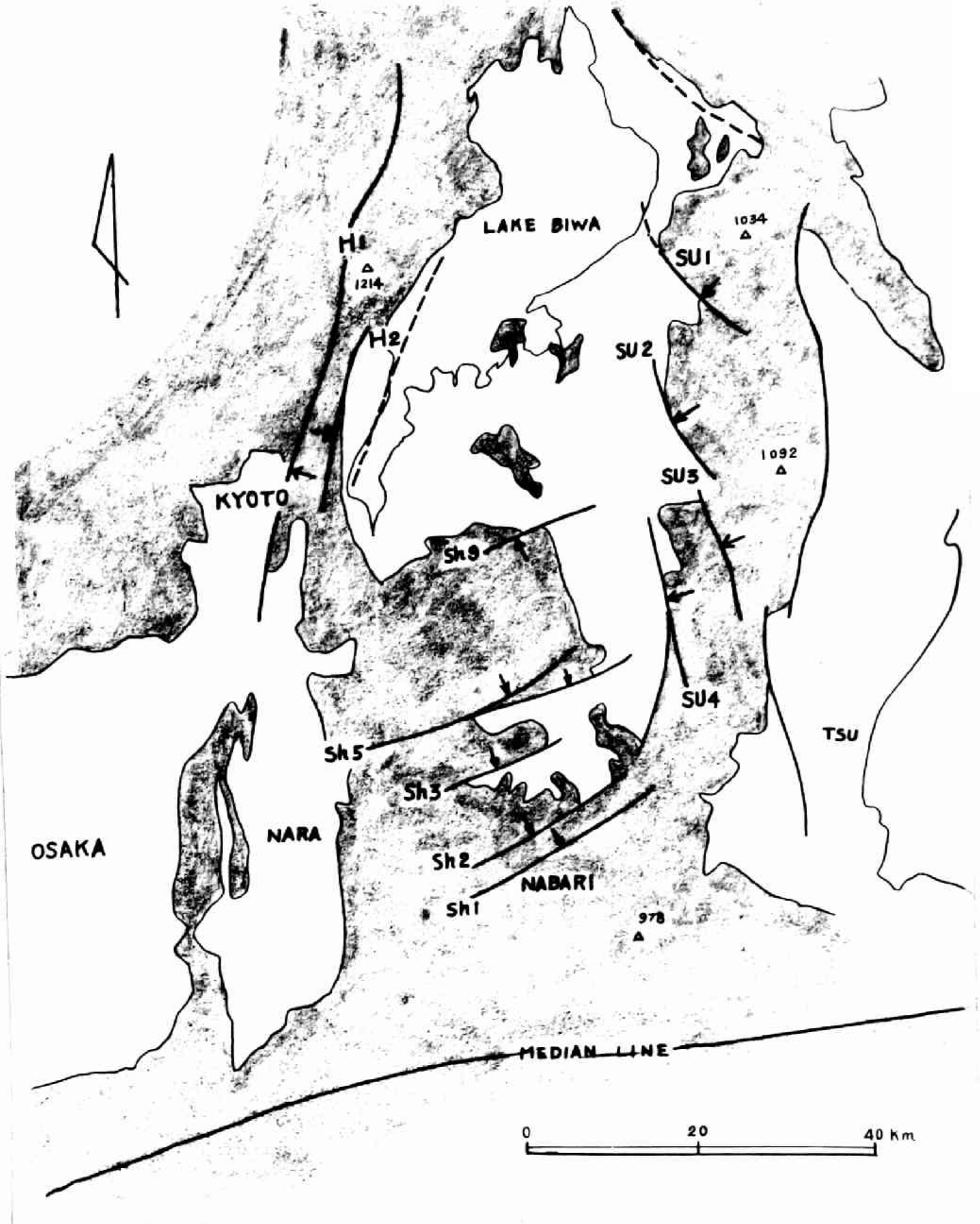
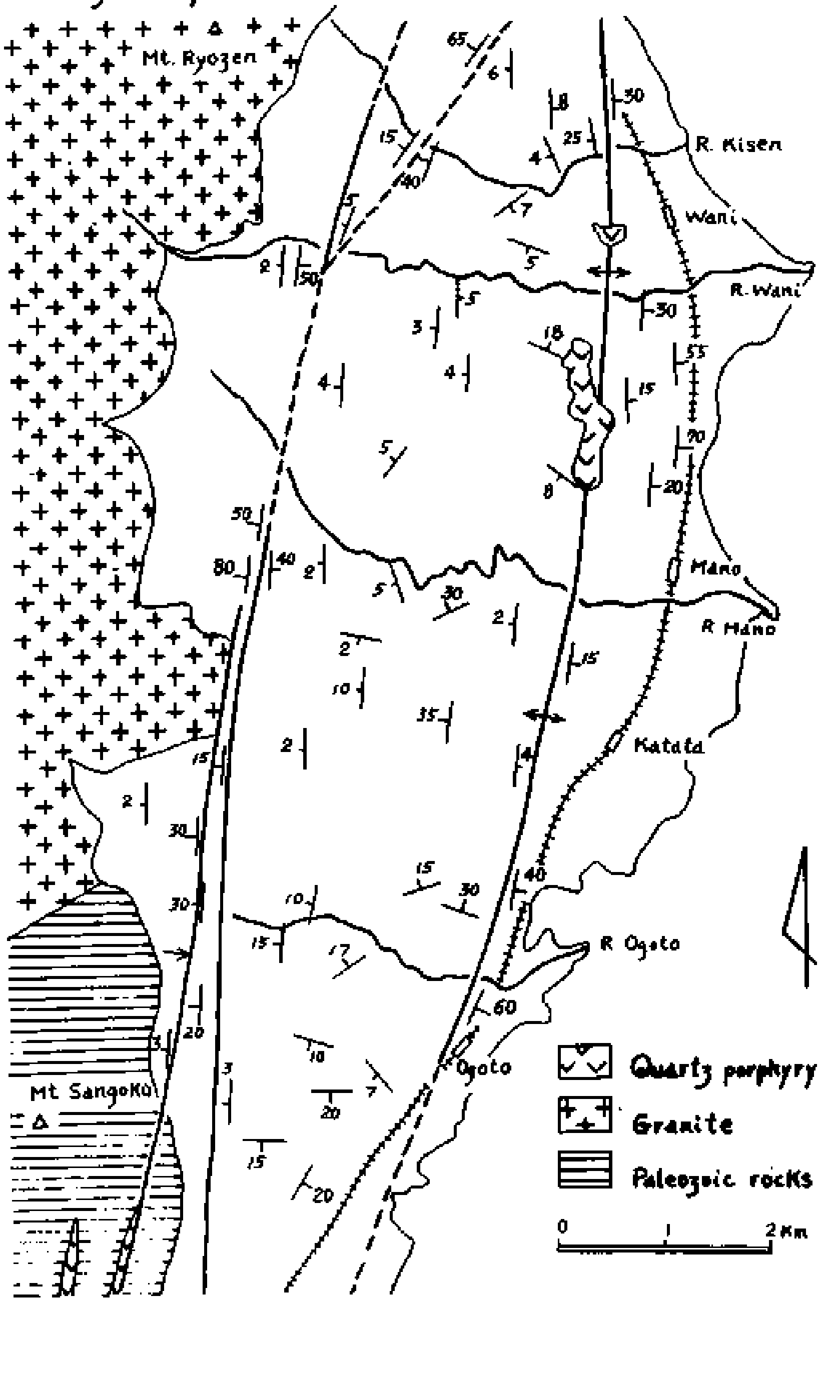


Fig.5 Dips and Strikes at Katata hill



Sketches of Fault

Fig. 6 At Oono (Sa 4)

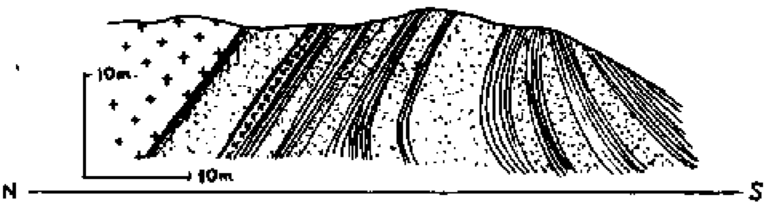


Fig. 7 At Noda (Sh 2)

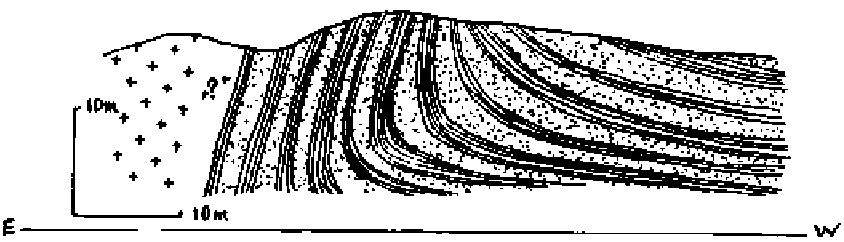


Fig. 8 At Mikumo (Sh 9)

Fig. 9 Terrace near Seta: Its distribution and schematic profile.

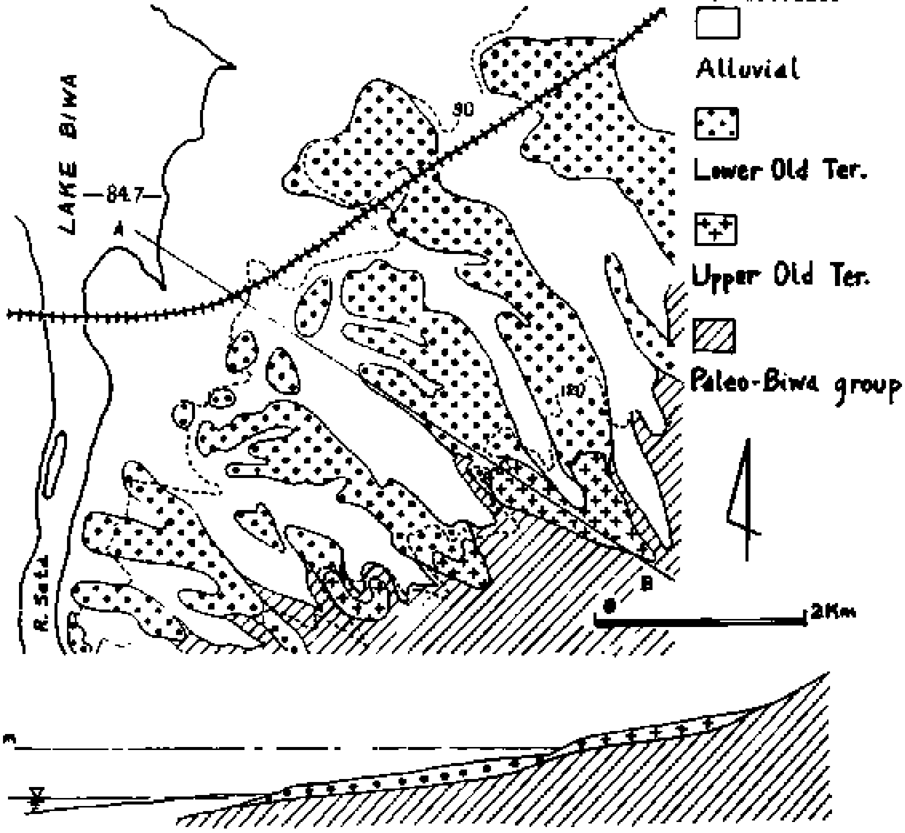


Fig. 10 Terrace near Echi Its distribution and schematic profile.

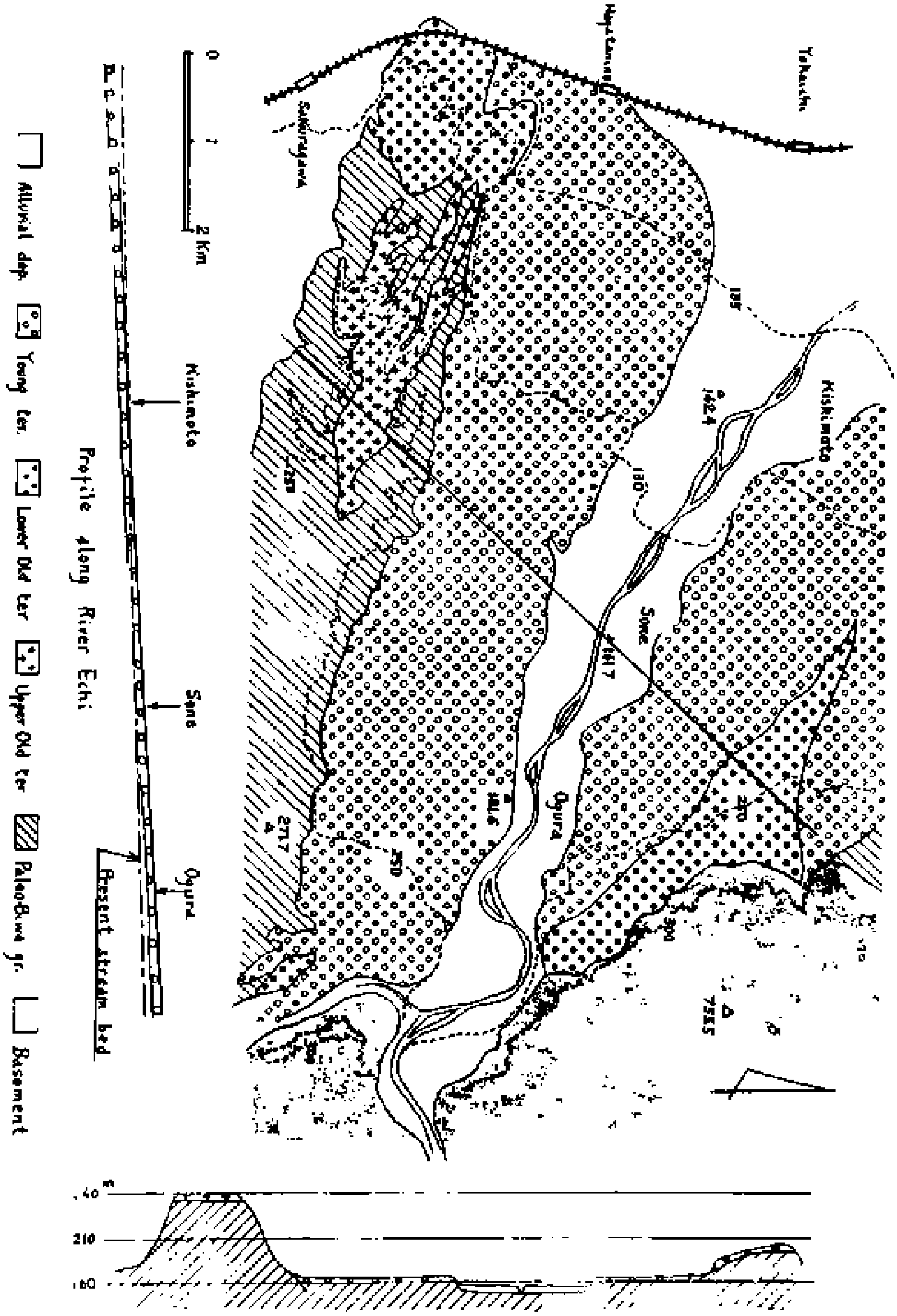
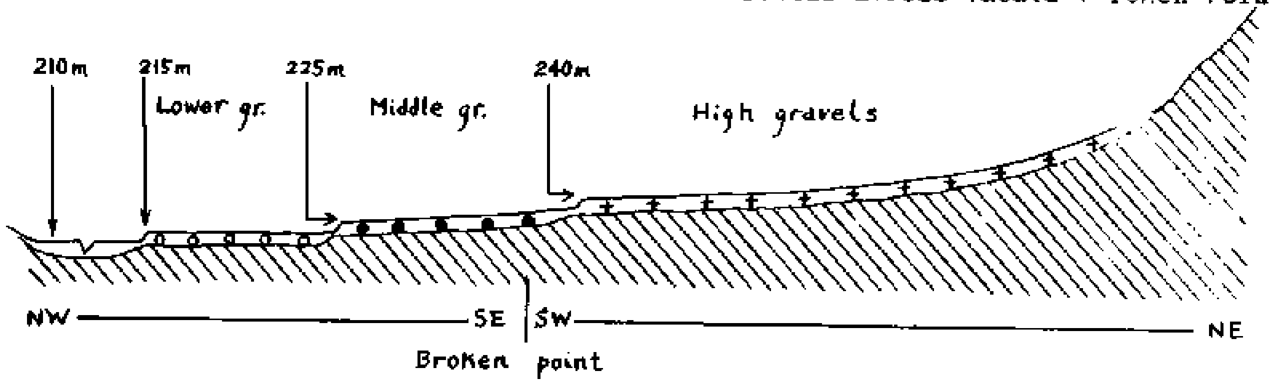


Fig. 11 Generalized Profile of Post Paleo-Biwa Gravels across Yabata (Broken Point



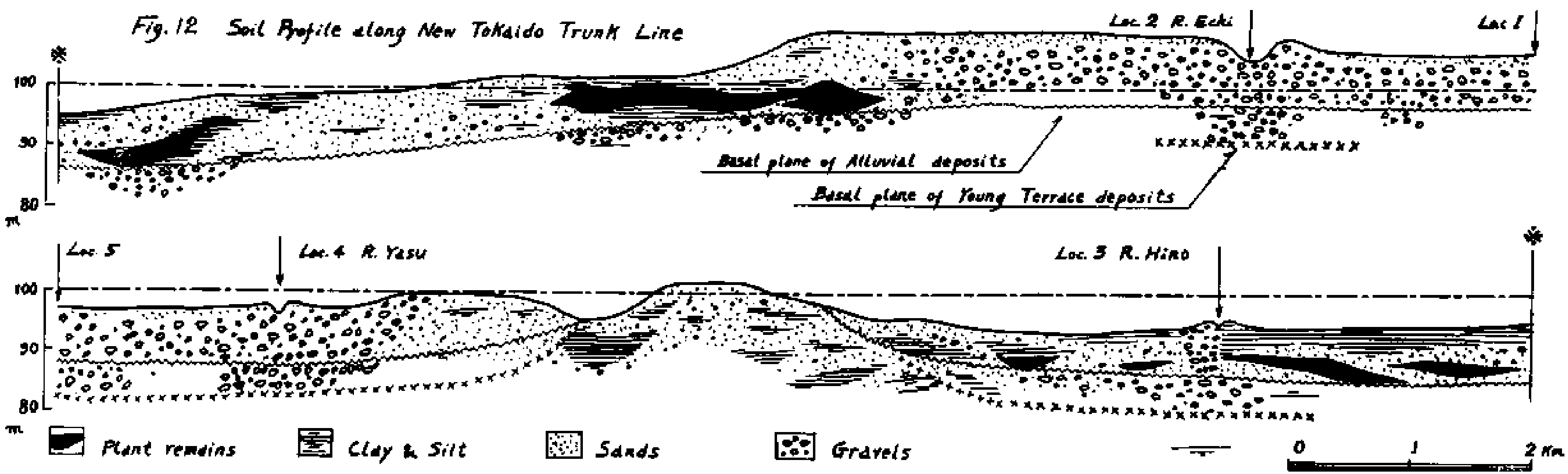


Fig. 12 Soil Profile along New Tokaido Trunk Line
Loc. 2 R. Echi
Loc. 1
100
90
80
m
Basal plane of Alluvial deposits
Basal plane of Young Terrace deposits
Loc. 5
Loc. 4 R. Yasu
Loc. 3 R. Hino
Plant remains
Clay & Silt
Sands
Gravels
0
1
2 Km

Table 13 Stratigraphical Table of Quaternary Sedimentaries in the Oomi-Iga Basin

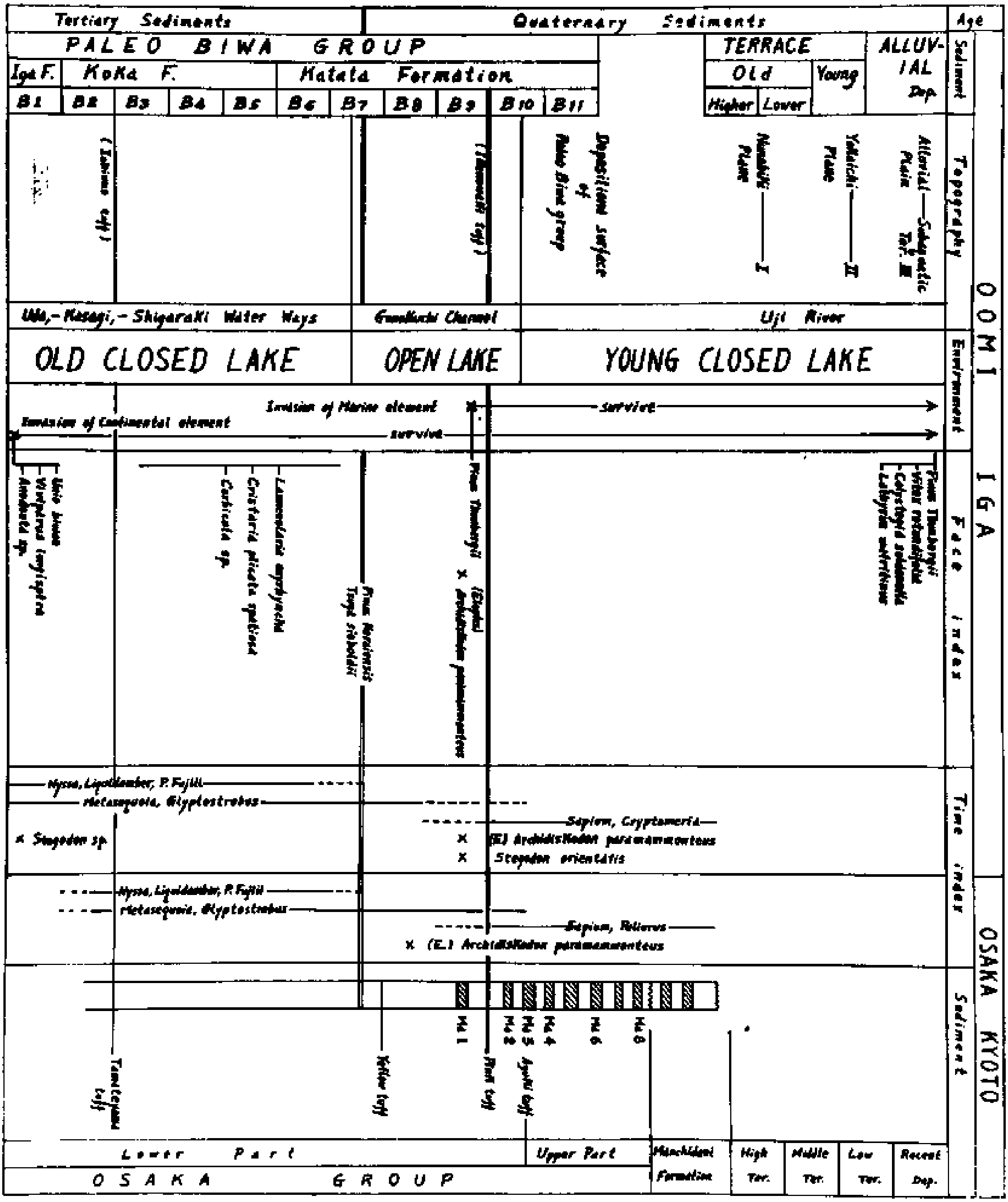


Fig.14 Map showing the Relation among Three Basins

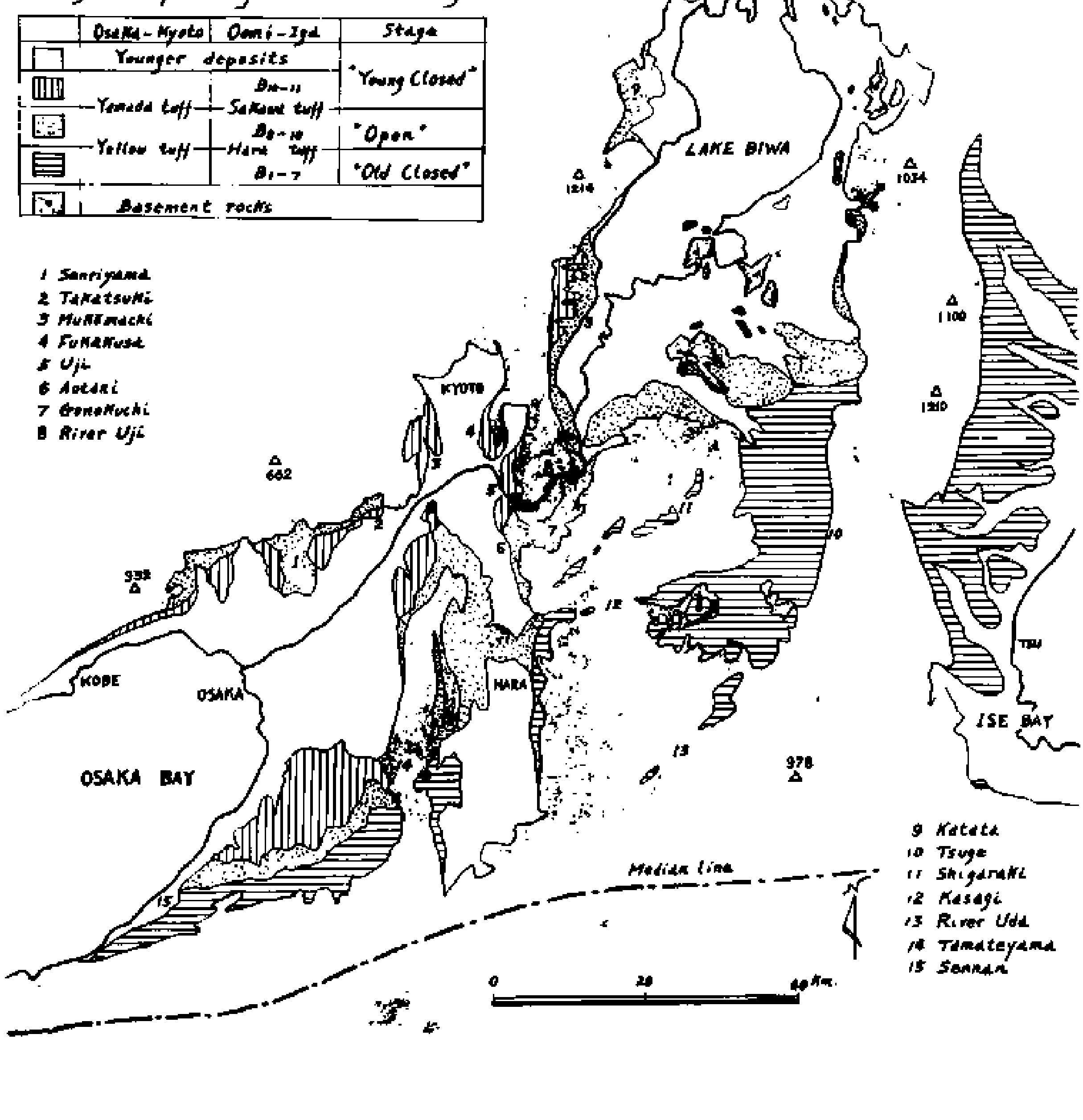


Fig. 15
Paleogeography of Late Pliocene in Age

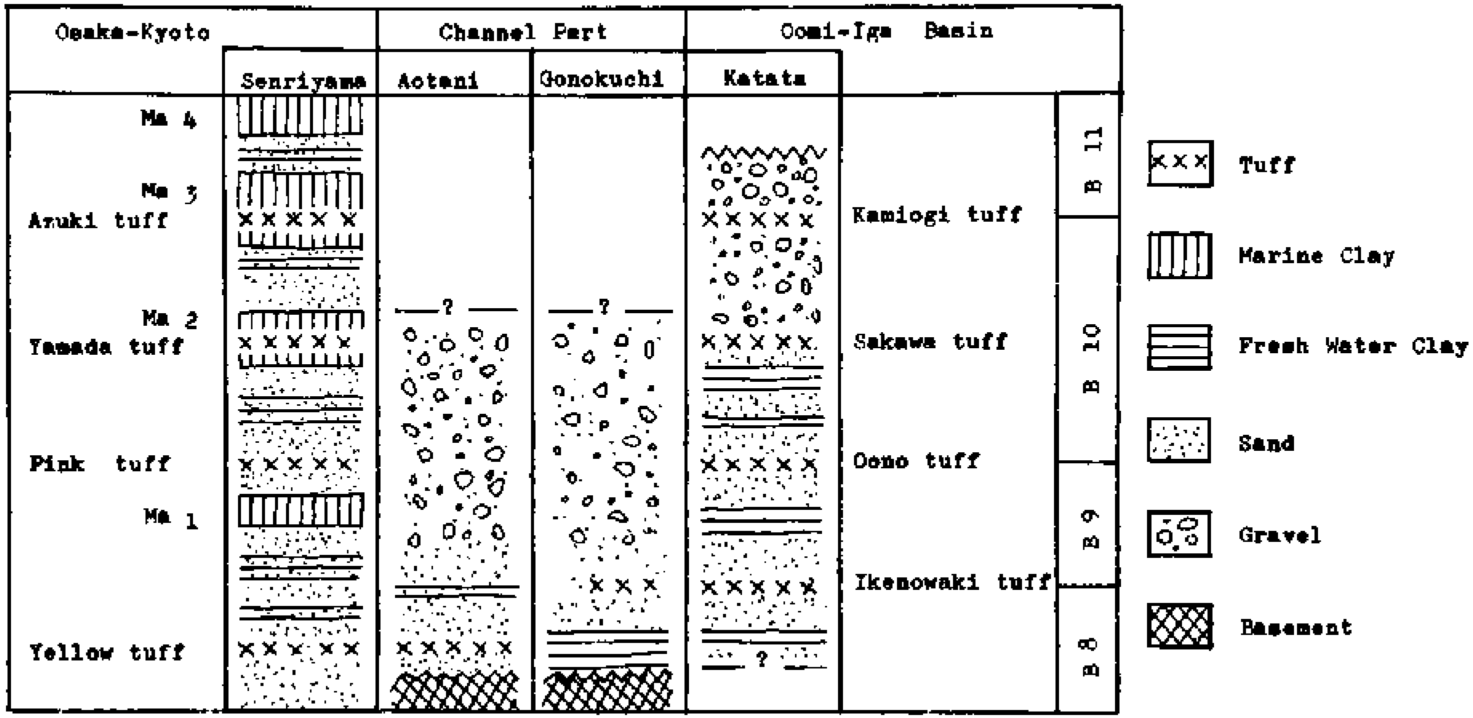
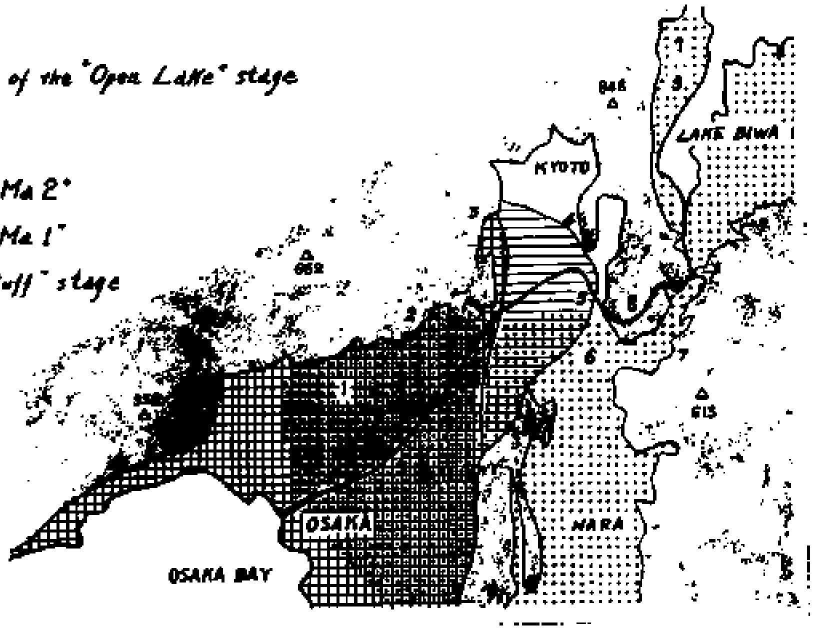


Fig. 16 Stratigraphical Relation between Osaka-Kyoto area and Oomi Basin.

Fig. 17 Paleogeographical map of the "Open Lake" stage



- Area with the marine clay "Ma 2"
- "Ma 1"
- Fresh waters at the "Yellow tuff" stage
- Basement

1 Senriyama
2 Takatsuki
3 Mukomachi
4 Fukakusa
5 Uji
6 Aotani
7 Gonokuchi
8 River Uji
9 Katata

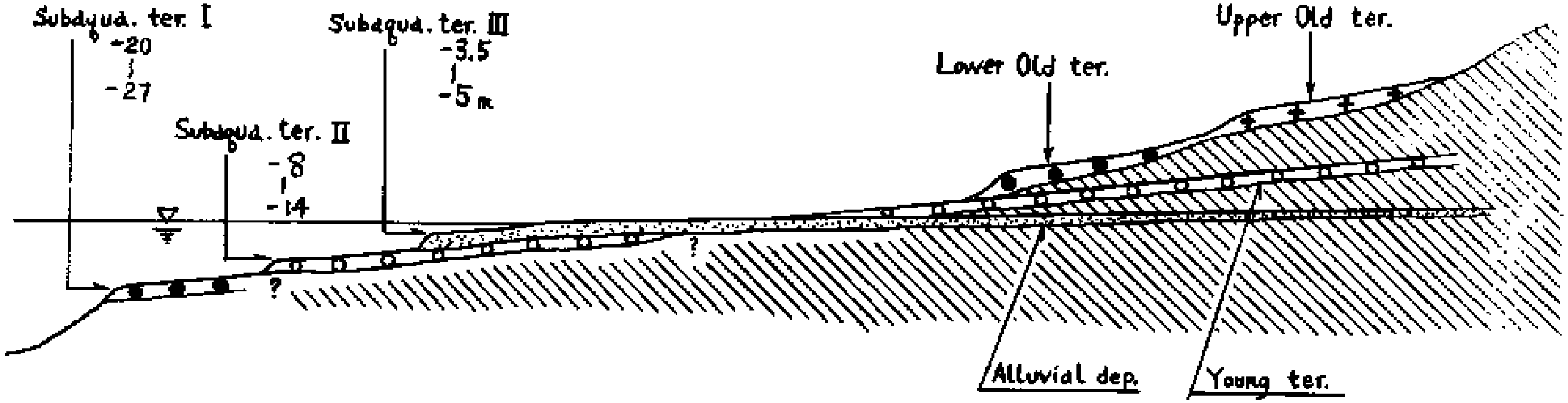


Fig. 18 Schematic Profile of Terrace and Alluvial Deposits.

Fig. 1

Geological Map of the Omi-Iga Basin

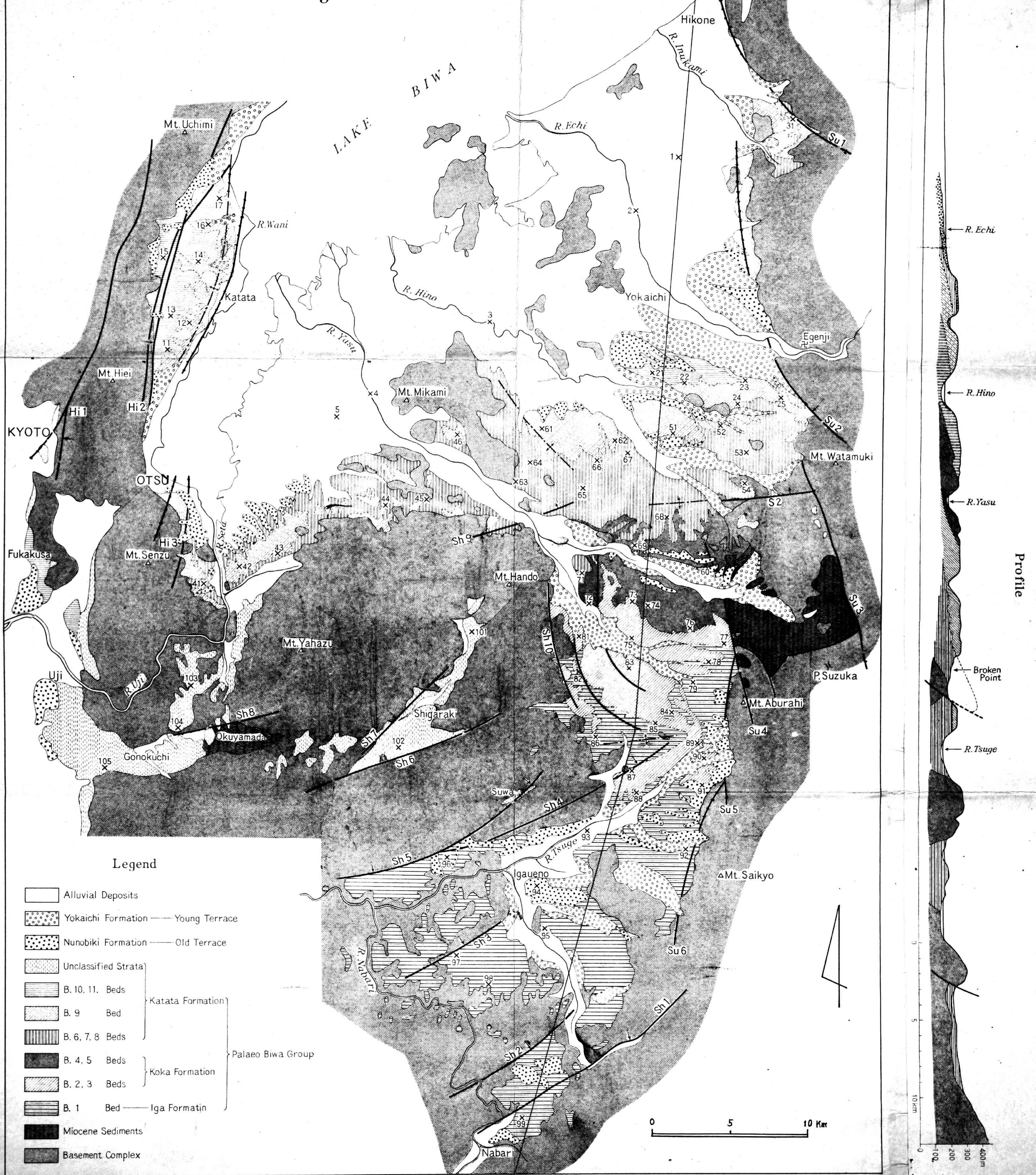
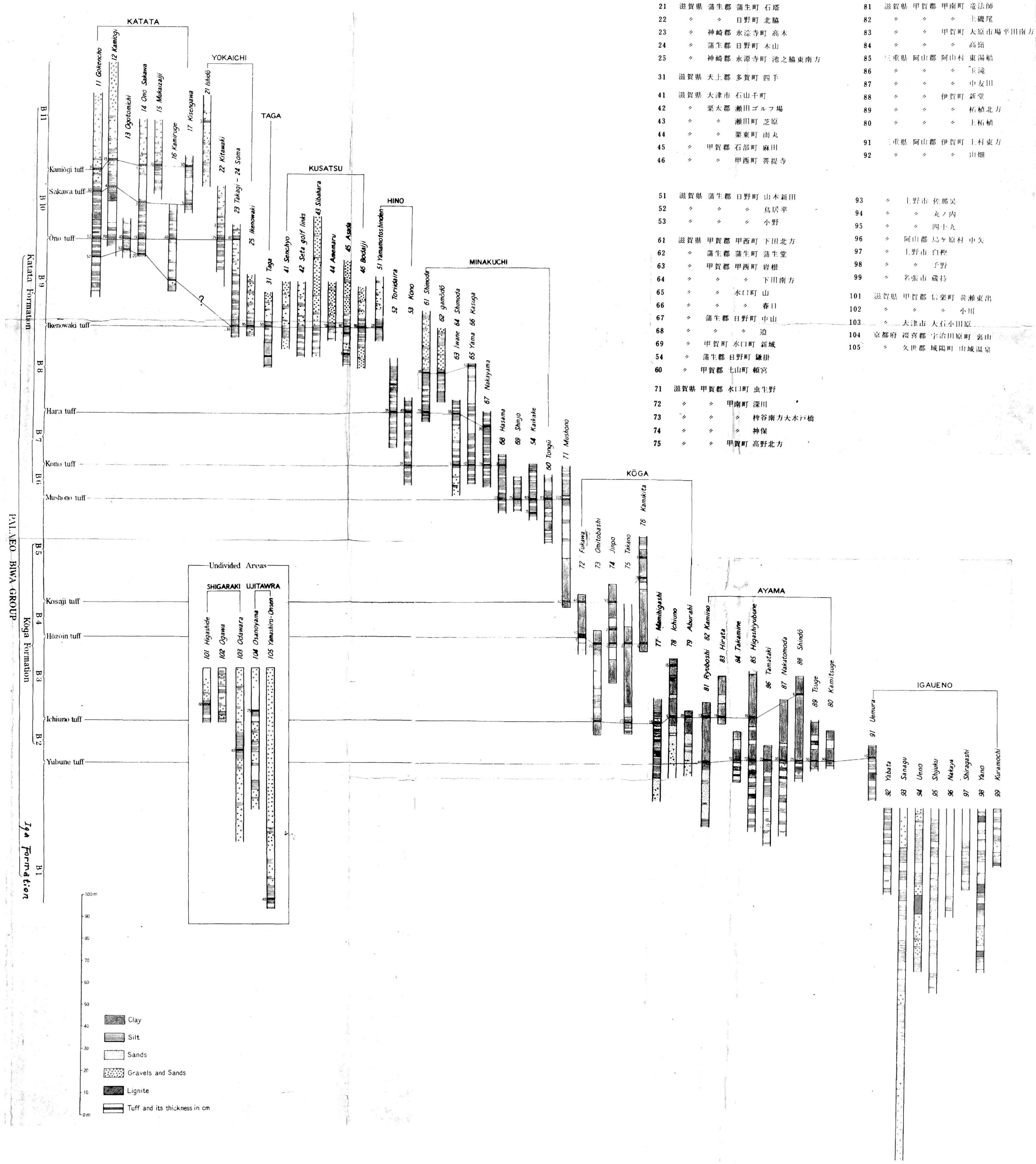


Fig. 2. Columnar Sections of the Paleo-Biwa Group



11 滋賀県 大津市 坂本五軒町
12 〃 滋賀郡 堅田町 上仰木西南方
13 〃 大津市 雄琴町 西方
14 〃 滋賀郡 堅田町 大野・佐川
15 〃 〃 〃 向在地
16 〃 〃 〃 上竜華
17 〃 〃 志賀町 喜撰川栗原下流

21 滋賀県 蒲生郡 蒲生町 石塔
22 〃 〃 日野町 北脇
23 〃 神崎郡 永源寺町 高木
24 〃 蒲生郡 日野町 木山
25 〃 神崎郡 永源寺町 池之脇東南方

31 滋賀県 犬上郡 多賀町 四手

41 滋賀県 大津市 石山千町
42 〃 栗太郡 瀬田ゴルフ場
43 〃 〃 瀬田町 芝原
44 〃 〃 栗東町 雨丸
45 〃 甲賀郡 石部町 麻田
46 〃 〃 甲西町 菩提寺

51 滋賀県 蒲生郡 日野町 山本新田
52 〃 〃 〃 鳥居平
53 〃 〃 〃 小野

61 滋賀県 甲賀郡 甲西町 下田北方
62 〃 蒲生郡 蒲生町 蒲生堂
63 〃 甲賀郡 甲西町 岩根
64 〃 〃 〃 下田南方
65 〃 〃 水口町 山
66 〃 〃 〃 春日
67 〃 蒲生郡 日野町 中山
68 〃 〃 〃 迫
69 〃 甲賀町 水口町 新城
54 〃 蒲生郡 日野町 鎌掛
60 〃 甲賀郡 土山町 頓宮

71 滋賀県 甲賀郡 水口町 虫生野
72 〃 〃 甲南町 深川
73 〃 〃 〃 榊谷南方大水戸橋
74 〃 〃 〃 神保
75 〃 〃 甲賀町 高野北方
76 〃 〃 〃 神北方
77 〃 〃 〃 神東方
78 〃 〃 〃 櫟野
79 〃 〃 〃 油日

81 滋賀県 甲賀郡 甲南町 竜法師
82 〃 〃 〃 上磯尾
83 〃 〃 甲賀町 大原市場平田南方
84 〃 〃 〃 高嶺
85 三重県 阿山郡 阿山村 東湯船
86 〃 〃 〃 玉滝
87 〃 〃 〃 中友田
88 〃 〃 伊賀町 新堂
89 〃 〃 〃 柘植北方
80 〃 〃 〃 上柘植

91 三重県 阿山郡 伊賀町 上村東方
92 〃 〃 〃 山畑

93 〃 上野市 佐那具
94 〃 〃 丸ノ内
95 〃 〃 四十九
96 〃 阿山郡 島ヶ原村 中矢
97 〃 上野市 白樫
98 〃 〃 予野
99 〃 名張市 蔵持

101 滋賀県 甲賀郡 信楽町 黄瀬東出
102 〃 〃 〃 小川
103 〃 大津市 大石小田原
104 京都府 綴喜郡 宇治田原町 裏山
105 〃 久世郡 城陽町 山城温泉